THE JUNE

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EDITED BY J. MCKEEN CATTELL

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THE SCIENTIFIC MONTHLY

JUNE, 1933

RESEARCH IN THE NATIONAL PARKS

By HORACE M. ALBRIGHT

DIRECTOR, NATIONAL PARK SERVICE

BEING equipped by nature with the most complete and magnificent laboratories imaginable, it was inevitable that scientific research should become an important and popular activity of the National Park Service. Nevertheless, it is one of the newest developments in national park work, which is primarily of a human welfare nature.

National parks began back in 1872, with the establishment of the Yellowstone National Park, the first reservation of its kind to be established anywhere. At the time of its establishment, of course, no thought was given to the scientific aspects of the geysers and other natural phenomena, yet it was because of their presence that the explorers of the Washburn-Langford-Doane party conceived the idea of a national park and gained the support to put this idea through Congress.

The organic act establishing the park provides that the area be "set apart as a public park or pleasuring ground for the benefit and enjoyment of the people," and further that regulations be enacted by the Secretary of the Interior "for the preservation from injury or spoilation of all timber, mineral deposits, natural curiosities or wonders within the park, and their retention in their natural condition."

On this foundation has grown up the great national park and monument system that to-day contains 22 national parks and 40 national monuments under the jurisdiction of the National Park Service of the Department of the Interior.

As park after park succeeded the Yellowstone, each was founded upon principles of human welfare, upon the idea of public ownership in and enjoyment of the parks. Yet the underlying motive in establishing each park for the benefit of the people was to preserve something precious from a special standpoint which, when analyzed, proved to be based upon some natural phenomenon or other object of interest to scientists or historians.

Thus the Yosemite, paradise of beauty, also is a geologist's paradise. Some of the Big Trees, to preserve which Sequoia and General Grant National Parks were set aside, were young in the days of the Pharaohs. Mount Rainier, the next to be established as a national park, contains the greatest single peak glacier system in the United States—in addition to exquisite wild flower fields and other features of impressive beauty. So throughout the system.

When the nineteenth century closed, these five national parks constituted the national park system.

The first decade of the twentieth century brought more of Nature's interesting laboratories into the system. There came Crater Lake, a lake of exquisite

T. J. Hileman

SWIFTCURRENT LAKE AND MOUNT WILBUR IN THE GLACIER NATIONAL PARK

blue in the crater of a volcano that collapsed or blew its head to bits sometime in the misty past; Platt, with hot springs possessing healing properties; Wind Cave, with unusual natural decorations and a strangely acting wind which blew in or out, apparently without rhyme or reason; Mesa Verde, ancient home of Basket-maker, cliff dweller, and Pueblo Indians, with a mysterious past that stirs the imagination of the ethnologist and archeologist, as well as that of the average layman; and Glacier National Park, that upturned section of the Rocky Mountains where ancient sedimentary rocks rest upon much younger strata, carved and scarified by great ice sheets and still holding in its mountain fastness the remains of sixty small glaciers.

The same year that Mesa Verde National Park was created Congress broadened the system by passing what is known as the "Antiquities Act." This legislation provided for the establishment, by Presidential proclamation, of national monuments of areas containing objects of historic, prehistoric or scientific interest.

As the national value of these parks and monuments became more apparent, the system grew steadily. The creation of Rocky Mountain National Park, including a typical area of the Rocky Mountains, was followed by two volcanic areas, showing a spectacular form of plastic surgery on the face of Old Mother Nature. One of these, Lassen Volcanic, contains our most recently active volcano on the mainland, and the Hawaii National Park, in addition to its vast dormant crater large enough to hold a modern city, also has two living volcanoes that periodically provide breathtaking displays of great beauty and sublimity.

Another far-away park, Mount McKinley in Alaska, contains the highest mountain on North America, snow-shrouded throughout the year. It affords remarkable opportunities for study of glaciers.

Three superb canyon parks in the Southwest, the Grand Canyon, Zion, and Bryce Canyon, show the wearing, tearing effects of water. Great granite mountains, glacier-laden, are the contribution of the Grand Teton National Park to the system. The huge chambers of Carlsbad Caverns National Park also attest to the dissolving, sculpturing powers of water, and the Hot Springs National Park also owes its place in the system to water—but in this case to medicinal waters, believed, ever since the days of the early Indians, to have definite healing powers.

Formerly a western institution, of recent years the National Park System has moved to the East. The Acadia National Park on the Maine Coast has ancient granite mountains that were old when the West was young; and the Great Smoky Mountains National Park, in addition to its hoary peaks, the highest mountain massing in the East, is famous for the variety and luxuriance of its flora.

The national monuments under the National Park System, established under the authority of the Antiquities Act, cover a wide range of objects. There are fossil plants, petrified trees, and the bones of the long-extinct dinosaur; cliff-dweller ruins and surface pueblos of long-vanished peoples; places connected with the lives of the first white men to settle in America and of early Colonial life; Revolutionary War Shrines; ruined churches erected by the padres who accompanied the gaily adventuring Spanish cavaliers to the New World; a fort built by the serious, patient Mormons—a wealth of areas of such scientific and human interest that their preservation is important to the advancement of our national culture.

Naturally, when the system was young, its first needs, like those of the young

Colorado Association

CLIFF PALACE IN THE MESA VERDE NATIONAL PARK

human, were protection and proper direction—or administration in the case of the parks. Protective or police organizations were first needed, then means to house the protective force and to care for the physical needs of the visiting public, in reality the parks' nonresident owners.

Once these elementary matters were well taken care of, the National Park Service turned to the aesthetic, or "higher educational" side of the parks. Interpretation of their natural features followed. Why geysers "gyze" is perhaps the question asked most in the Yellowstone. In Yosemite, upon seeing Half Dome, visitors want to know what became of the other half—and with the opportunity thus afforded for tactfully imparting a little scientific information the educational work goes on apace, apparently casually, but always based upon careful research.

The guided field trips and popularly worded lectures of to-day, as well as the museum service, grew out of this demand of the visitors to know the "why" of the interesting phenomena—although most of them do not call it that—encountered along the way.

Museum work, in the parks particularly, is quite specialized. The museums are so arrayed as to give the observer a glimpse of the interesting things to be found out in the parks themselves—to interest him to see for himself what the museum suggests. In other words, the museum exhibits are only the indices to the real museum, which is the park.

NATURE GUIDE PARTY ON THE TOP OF EAGLE PEAK IN THE YOSEMITE NATIONAL PARK

In the historic and prehistoric members of the system, of course, the museums serve a different purpose. There they actually display relics of human lives — in the former, of our pioneer forbears; in the latter, of a vanished, almost unknown race. A prehistoric burial place yields a skeleton and a few

VIEW DOWN THE GRAND CANYON FROM LIPAN POINT
IN THE GRAND CANYON NATIONAL PARK.

Copyright, J. E. Haynes
A BUFFALO HERD IN LAMAR VALLEY, YELLOWSTONE NATIONAL PARK

trinkets; a plastered-up cache high in a cliff, when opened is found to contain pottery or basketry; here there is a grinding stone and there a weapon of the chase. These all are studied and gradually some idea of the lives of the prehistoric peoples takes shape. This is one of the most fascinating phases of the research work of the National Park Service.

—*Ranapar Studio*

A BANK OF AVALANCHE LILIES

IN UPPER PARADISE VALLEY IN THE MOUNT RAINIER NATIONAL PARK. ALTHOUGH THE LILIES ARE BLOOMING PROFUSELY, LARGE PATCHES OF SNOW MAY BE SEEN LINGERING BUT A FEW YARDS AWAY.

Research is necessary not only to the preparation of interesting material to serve as a basis of the naturalist and historical service, but it also is fundamental to the actual protection of the natural features of the parks, as enjoined in the acts establishing the parks and in the act of August 25, 1916, creating the National Park Service. The latter act contains the following clause:

> The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

There are a great variety of natural objects in the national parks. There are the wild animals, objects of intense in-

terest to visitors, who can not see elsewhere such a wide variety of species and numbers as in these areas, since only in the national parks and national monuments are they given complete protection. The plant life, both tree and wild flower, also makes a tremendous appeal to the average visitor, for one can imagine nothing lovelier than the fields of wild flowers that carpet most of the parks during the spring and early summer. Then there are the natural scenic, scientific, and historic features, the main object of the parks' establishment. All of these natural objects need protection, and in many cases research is necessary to determine the cause of some suddenly-appearing adverse condition.

Formerly protection of the wild life was primarily a protective function, involving long ski patrols in the winter to afford protection against poachers, both hunters and trappers, and the occasional supplying of food in emergencies. Also in the Yellowstone there has been for a number of years the winter care of the buffalo herd, numbering over a thousand.

BRYCE CANYON NATIONAL PARK

TOURISTS ON THE TRAIL BELOW SUNRISE POINT WITH A PARK RANGER. QUEEN'S GARDEN AND QUEEN'S CASTLE ARE IN THE BACKGROUND. SUNSET POINT IS AT THE LEFT ON THE RIM.

Following fundamental protection came the restocking of certain depleted natural ranges. Before going farther with this particular subject, it is important to emphasize that the policy of the National Park Service is unalterably against the introduction of exotic species of animals or plants in the national

—*T. J. Hileman*

TOURISTS AT TUNNEL WINDOW, GLACIER NATIONAL PARK

GRAND TETON NATIONAL PARK

THE TETONS, SOUTH OF GLACIER CANYON, AS SEEN FROM THE OLD ELK-GROVONT POST ROAD ABOUT 4 MILES SOUTH OF ELK. LEFT TO RIGHT: ALPENGLOW, TAGGART CANYON, MOUNT WISTER, MOUNT MICHAUD, SOUTH TETON, MIDDLE TETON, GRAND TETON, TEEWINOT, MOUNT OWEN, GLACIER CANYON.

parks or national monuments, except for the occasional stocking of an otherwise barren body of water with some species of game fish for the enjoyment of lovers of the Waltonian sport. Wherever animals are introduced, it is to restock a natural range which has become depleted because of some unnatural condition or series of conditions.

Prominent among the restocking experiments are those of the bison—more generally called buffalo—in the Yellowstone, and the antelope at the Grand Canyon. Yellowstone National Park, one of the great areas ranged by buffalo in their wild state, suffered from a depletion in the herds of these animals almost to the point of extinction. A few new animals, specially selected from Texas and Montana herds, were introduced into the park, intensive management undertaken, and to-day the bison herd numbers over a thousand and could be much larger were the range sufficient to support a greater number.

In the Grand Canyon an interesting restocking effort with antelope is just passing out of the experimental stage. At one time these plains antelope were plentiful at the Canyon but changing conditions—possibly caused largely by the wide spreads of the descendants of hardy burros left in the Canyon by prospectors lured to other fields—brought about their disappearance from their former range. In 1924, twelve antelope kids, six bucks and six does were taken to the Canyon, fed and kept under close observation for some time, then released on the Tonto Platform, where it was hoped they would thrive and multiply. For several years prospects looked bad for the survival of these antelope, as they did not easily adapt themselves to new conditions and, possibly because of their careful raising by hand, easily became a prey to predatory animals. After five years of fighting against odds, by the end of 1929 the herd included only nine animals, four of them kids. During the past year conditions have materially improved, however, and there are twenty animals in the herd. Of ten kids born last spring, eight have survived. The outlook now is favorable for the building up of a large herd which it is hoped can be drawn upon a few years hence for the stocking of other natural antelope ranges in the national park and monument system.

Another interesting experiment at the Grand Canyon has been the transportation of deer from the North Rim across to the South Rim. At first these animals were transported across the Canyon by truck over a long detour covering a distance of 240 miles and requiring from twenty-four to thirty hours to make the trip. Later, for several years, young fawns were transported by a combination airplane and truck trip which was made in three hours. Introduction of these animals to the South Rim, and enlargement of the semi-tame herd over a period of five or six years, has been the means of presenting the public with a highly interesting feature of wild life. In addition, this herd has attracted other deer from regions adjacent to the park, thus increasing the herd to an estimated total of 1,200 head.

Of recent years it has become evident that ranger protection and restocking are not sufficient for the complete preservation of the wild animals. While in the parks it is true that the animals live as nearly as possible under primitive conditions, civilization comes close to the park boundaries, modifying the wilderness conditions; the animals wander back and forth across the boundaries, often coming in contact with domesticated animals, and thus meet vastly different conditions to those experienced by their ancestors back in the middle nineteenth century. Because of this, many situations have arisen necessitating scientific study.

Again, to mention the Yellowstone buffalo, an epidemic broke out several years ago which threatened the decimation of the herd. Experts of the Bureau of Animal Industry were called upon and studies made of the disease. It was diagnosed as hemorrhagic septicemia, and the buffalo were vaccinated against it—not an easy task, as any one who has ever seen these enormous animals in stampede will realize. To-day the herd is thriving—so much so that animals have to be given away each year to keep the number of bison in the park down to the number the range can support satisfactorily.

So one study has followed another, to relieve emergency conditions, and in all such cases the National Park Service has received the unstinted cooperation of the Biological Survey and the Bureau of Animal Industry.

It has become increasingly evident, however, that a management plan of some sort must be inaugurated by the National Park Service, in order to restore and keep the park wild life in its primitive state despite the effects of human influence. This necessitates, first of all, complete investigation.

Realizing the need of this, an outline of wild life studies was prepared and work along this line undertaken in 1929 with funds made available by George M. Wright, who had become interested in the problem while serving with the educational department in Yosemite National Park. Joseph S. Dixon, economic mammalogist and scientist connected with the Museum of Vertebrate Zoology, was persuaded to assist in this work and he, Mr. Wright, and Ben H. Thompson have carried on the studies with increasing interest and vigor. Since 1931 the National Park Service fortunately has been able to assist in

"THE WATCHMAN" IN THE ZION NATIONAL PARK

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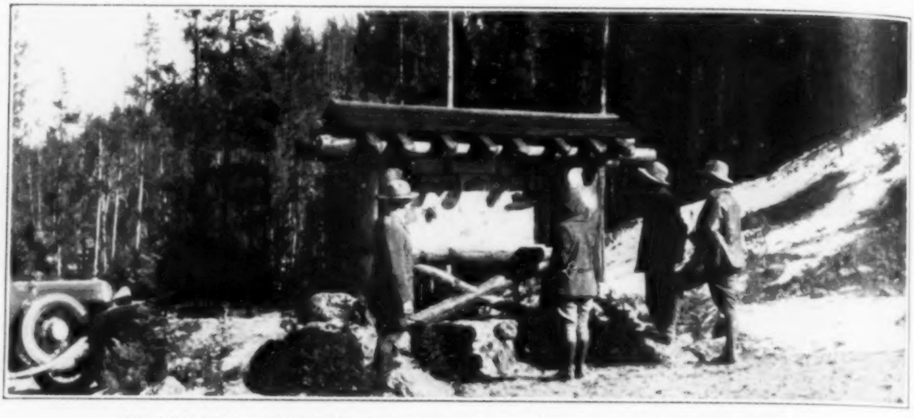
RIVERSIDE GEYSER, YELLOWSTONE NATIONAL PARK



TRAILSIDE SHRINE IN YELLOWSTONE NATIONAL PARK

WAYSIDE EXHIBITS ARE LOCATED AT STRATEGIC POINTS AND SERVE AS GUIDES TO THE MOST INTERESTING HISTORICAL AND NATURAL FEATURES OF THE AREA.

financing this work, and during the coming fiscal year will take over practically all the expense.

In their first printed report on the result of their studies, the members of the Wild Life Studies Group report as follows:

> . . . throughout the preliminary survey, fixity to the main purpose of obtaining a perspective of the problem in its entirety has been the paramount consideration. Consequently, the search focused on the general trends in the status of animal life, with particular regard to the motivating factors. If a finger can be placed on the mainsprings of disorder, there is hope of discovering solutions that will be adequate in result. Meeting existing difficulties with superficial cures might be temporarily expedient and, in cases of emergency, necessary, but if continued would build up a costly patchwork that must eventually give out. It would be analagous to placing a catch-basin under a gradually growing leak in a trough and then trying to keep the trough replenished by pouring the water back in. The task mounts constantly and failure is the inevitable outcome. The only hope rests in restoration of the original vessel to wholeness. And so it is with the wild life of the parks. Unless the sources of disruption can be traced and eradicated, the

VIEW OF NORRIS MUSEUM AT YELLOWSTONE NATIONAL PARK

NATIONAL PARK MUSEUMS HOUSE MANY VALUABLE EXHIBITS WHICH SHOW RESEARCH RESULTS.

wild life will ebb away to the level occupied by the fauna of the country at large. Admitting the magnitude of the task, it still seems worth the undertaking, for failure here means failure to maintain a characteristic of the national parks that must continue to exist if they are to preserve their distinguishing attribute. Such failure would be a blow injuring the very heart of the national-park system.

One of the most interesting studies undertaken by this group is in connection with the trumpeter swan, one of the birds of present-day America that appears to be fast approaching the end of its journey to join the dodo in the limbo of forgotten things. It has been found that in the Yellowstone region these birds are making a last stand, and the Wild Life Division, with the cooperation of Yellowstone National Park officials, is bending every effort toward affording the necessary conditions in the park to permit the rehabilitation, if one may call it that, of this magnificent species of bird. Reports now indicate that the possibility is good for giving this species a new lease on life, just as was done in the case of the buffalo.

Typical of wild-life research of a cooperative nature has been the study of the Yellowstone elk by William Rush, an investigation initiated by the writer when superintendent of Yellowstone National Park, and later supported jointly by the Forest Service, the Biological Survey, the Montana Fish and Game Commission, and the National Park Service.

Plant life problems, while perhaps not as pressing as those pertaining to the wild animals, are equally important. Forest fires present a constant potential menace to the trees, but improvement methods of fire prevention and combat are handling this problem excellently.

Other enemies of park forests are insect infestations and tree diseases. Just as in the case of the wild animals, changing conditions outside park boundaries affect the trees inside. Insect devastations generally start outside the parks, from there encroaching on the trees inside.

Recent surveys show several serious forest situations prevailing in the na-

OBSERVING THE WONDERS OF GRAND CANYON

TELESCOPES AT YAVAPAI OBSERVATION STATION AND THE ASSISTANCE OF A RANGER-NATURALIST AID VISITORS IN THEIR STUDY.

THE GEORGE WASHINGTON BIRTHPLACE NATIONAL MONUMENT

PROFESSOR ESSIG'S UNIVERSITY OF CALIFORNIA ENTOMOLOGY CLASS AT THE YOSEMITE MUSEUM

tional parks. One of the worst occurs in the Yellowstone, where the mountain pine beetle threatens the destruction of the lodgepole pine that constitutes about eighty per cent. of the park forest. This epidemic has been carefully studied by experts of the Bureau of Entomology, as well as by Park Service men and officials of the adjoining national forests. It appears that there would be perhaps a fifty-fifty chance of saving these lodgepole pines if a five-year program of control could be undertaken immediately, at a probable cost of from $3,000,000 to $5,000,000.

This matter was discussed with the Appropriations Committee of the House of Representatives over a year ago. At that time it was decided that such an enormous expenditure was not justified, particularly as there is no definite assurance that even with such appropriations could the ravages of the infestation be stopped.

Another menace to park forests exists in the white-pine blister rust, which first appeared in the East, moved across Canada, and is now coming down into western United States through Washington, Oregon and Idaho. Blister rust control measures have been carried on successfully for several years in Acadia National Park in Maine, and it is believed that by the end of this year the white pine of Acadia will be out of danger through the eradication of host plants. In Mount Rainier Park, in the State of Washington, control measures were inaugurated last year to save a few selected stands of white pine. This work will have to be followed up intensively for a year or two, however, if any worthwhile areas of white pine are to survive in that park.

AN OUTDOOR AMPHITHEATER FOR LECTURE PROGRAMS

HERE, AT OLD FAITHFUL, DAILY TALKS ARE GIVEN BY A RANGER-NATURALIST ON THE SCIENTIFIC FEATURES OF YELLOWSTONE.

Blister rust is a fungus, its alternate host plants being the currant and gooseberry. It has been discovered that the fungus can move only a small distance from host to pine, but that after reaching the pine it can move a long distance to other host plants. So the method of control is to eliminate the host plants within the necessary radius. Present indications are that in the West control measures can be taken effectively.

LOOKING THROUGH THE TELESCOPE AT SUNRISE LODGE IN MOUNT RAINIER NATIONAL PARK

If this is not done, experts of the Bureau of Plant Industry state that the resultant damage to the five-leafed pine forests of the West will be a national calamity.

A tree problem in Sequoia and Yosemite National Parks was involved in the use of the Big Tree areas by the visiting public. It was found that the constant tramping of feet around several of the oldest and largest of these trees was wearing away and packing down the ground cover to an extent that was threatening the very life of the trees. Careful studies of existing conditions led to the protection of the tree-root areas from encroachment, and the soil, which had been heavily compacted, was brought back to normal by covering the ground with forest litter and the planting of native shrubs. Dr. E. P. Meinecke, general adviser to the National Park Service on matters of forest pathology, reported recently that the oldest of the Big Trees in Yosemite, the Grizzly Giant "is in decidedly better condition now than it was six years ago. The little branchlets no longer droop as they did a few years ago, but have come back a normal bright green." This means that this old tree, estimated to be about four thousand years old, has been brought back to health, and may watch the generations come and go for a few more thousand years.

So it goes on, through a long list. As one floral or faunal problem is solved, another is presented. And the inorganic features also have their problems, often requiring a great deal of research before a solution is reached. Volcanoes are studied, investigations are made of the geyser fields, where activity in one place ceases, only to break out in another. The effects of glaciers and of running water on granite and other rocks are

given attention by one group of scientists, while another is interested in the formation of great colorful canyons by the effects of wind and rain.

An especially interesting discovery at the Grand Canyon, made possible through the cooperation of the Carnegie Institution of Washington and the National Academy of Sciences, was of fossil plants and the traces of many extinct animals. Both plants and animals dated back to the age of coal plants. In the Algonkian rocks, the strata which represents one of the earliest periods from which remains of life have been obtained, were found fossils of algae, or very low types of plant life.

More than twenty distinct forms of hitherto unknown animals were discovered, not from petrifications or fossilized bones, but merely from footprints made by these creatures in soft, probably moist sands. Some quick covering of the sands hardened and preserved the footprints, to the end that ages later some of them might be unearthed as workmen split the rock in building a new trail, to become part of the educational program at the Grand Canyon National Park.

Increasingly experts of the National Park Service are making studies along various specialized lines, while at the same time the Service welcomes the many investigations inaugurated and carried through by organizations and individual scientists.

While perhaps not strictly in line with the general trend of this article, which has referred to research primarily from the standpoint of education, some mention should be made of the valuable research being done along landscape and sanitary lines, the former by landscape architects and architects of the National Park Service, and the latter by sanitary engineers of the Public Health Service in cooperation with the Park Service.

Again from the educational standpoint—the incalculable value of the national parks and national monuments as research laboratories has been recognized by a number of schools, including important universities, and many field classes are held therein, particularly in ecology, geology and archeology.

There is no doubt but that this use of the parks as field schools will increase in the future, side by side with the growth in tourist travel. Thus the parks have an important destiny in the future of our national life, from the standpoints of educational, spiritual and recreational values.

A TRUMPETER SWAN AND HER BROOD

THIS SPECIES WAS ALMOST EXTINCT, BUT RECENT INVESTIGATIONS HAVE DEVELOPED BASIC KNOWLEDGE AND NEW METHODS FOR ITS CARE AND PROTECTION. SCENE IN YELLOWSTONE NATIONAL PARK.

THE WORK OF THE NATIONAL BUREAU OF STANDARDS IN METROLOGY AND MECHANICS

By Dr. LYMAN J. BRIGGS
ACTING DIRECTOR

WEIGHTS AND MEASURES

IN a vault at the National Bureau of Standards two pieces of platinum-iridium alloy are preserved with great care because they constitute the basis of the whole system of weights and measures used in the United States. One is the standard of length, the standard meter; the other the standard of mass, the standard kilogram. From the fundamental units of length, mass, and time (the second) all other units used in science and engineering may be derived, with the exception of the unit of difference in temperature.

The Bureau has, in fact, four meter-bars, three of them being used as secondary and working standards. These four bars originally formed part of a large group of standard meter-bars which were constructed by an International Commission in 1889. All of these bars were graduated as nearly identically as possible. After an extended intercomparison, one of the lot was designated as the International Meter and deposited at Sèvres while the others were distributed to the various nations of the world.

Subsequent comparisons of our standard meter with the international meter were made in 1903 and again in 1923. These comparisons showed that within the limits of accuracy of the measurements the length of our standard meter has remained constant since its original calibration in 1889. Moreover, the length of the international meter has been measured by Michelson and also by Benoit, Fabry and Perot in terms of the wave-length of red cadmium light, so that the meter may properly be said to be well established as a fundamental unit of length.

The meter and the kilogram are fundamental units of the metric system. Inasmuch as the English system of units is largely used in this country, one may properly ask why the system of units should not be based upon a standard

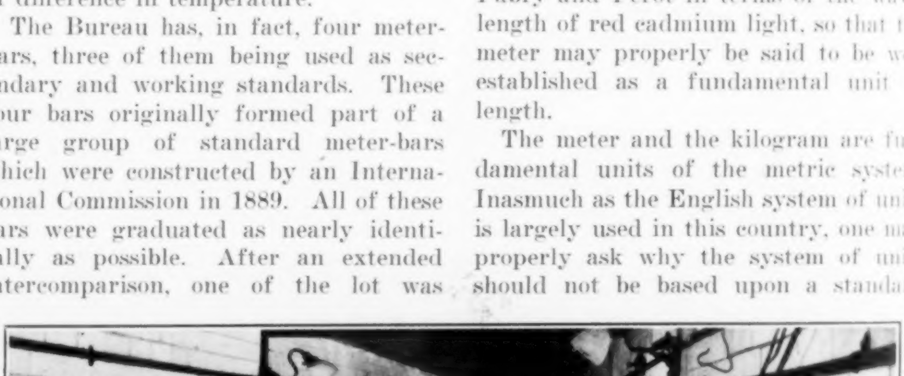


FIG. 1. TAPE TUNNEL
USED IN STANDARDIZING SURVEYOR'S TAPES.

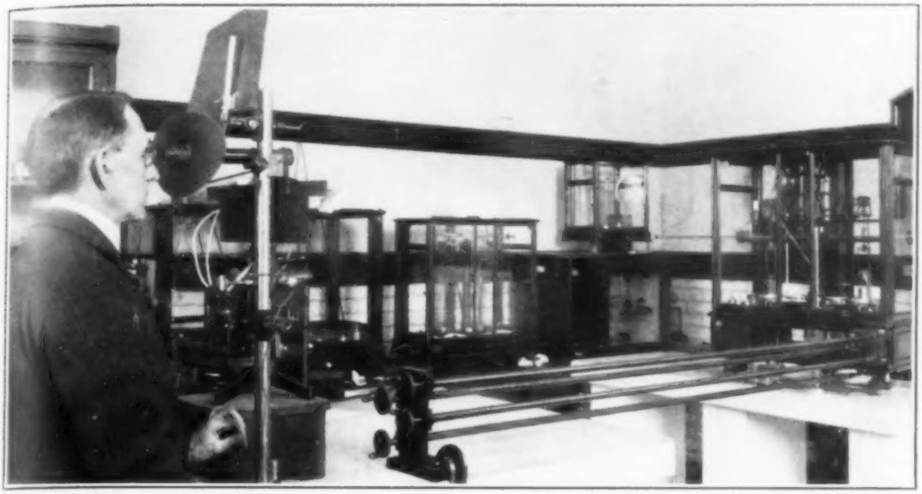


FIG. 2. PRECISION WEIGHING
DISTANT CONTROL OF BALANCE AND WEIGHTS.

yard and a standard pound, instead of the meter and the kilogram.

When Congress legalized the use of the metric system in the United States, it stated that "for practical purposes" one meter is equivalent to 39.37 inches. This ratio made it possible to derive the inch and its multiples from the standard meter, and consequently it is unnecessary to have a fundamental yard standard. Recently, industrialists in this country and in England have asked that the ratio 1 inch = 25.4 millimeters exactly be used in certifying gages for industrial use. This ratio differs from that mentioned above by only 2 parts in 1,000,000, which is of no practical significance. It is of interest to note that the general agreement to adopt this simple commensurate ratio was facilitated through the establishment of European factories for the manufacture of American automobiles.

The constancy of our primary standard of length is not only of fundamental importance in all scientific work, but it is the basis in fact of some of our great modern industries. Mass production of machines such as automobiles is dependent upon the interchangeability of parts. These machines are literally built up from bins of parts, the parts in each bin being so nearly alike that they can be used interchangeably. Furthermore, the parts are not all manufactured in the same plant, but the ball-bearings may be obtained from one factory, the bushings from another, the gears from a third, the pistons from a fourth, and so on. The housing for the bearing and the axle of the car are finished to such accurate dimensions that on assembly the bearing slips into place without looseness and without strain. Pistons and cylinders, piston-pins and connecting-rod bearings, and other parts that move relative to each other are made with such exactness that they perform smoothly during thousands of miles of driving. How is this remarkable thing accomplished? It is accomplished through untiring attention to standards. The master gages of these various factories are checked with great care against the dimensional standards maintained at the Bureau. These master gages in turn are used in each factory to check the working gages, with which the product

is finally compared. Thus every article used in industry, whose exact dimensions determine in part its commercial value, has been compared directly or indirectly with the length standards maintained at the Bureau. Uncertainty in these fundamental standards of length or any drifting in their assigned values would result in indescribable confusion, delay and economic loss.

Another important application of these fundamental length standards is to be found in the determination of the exact length of the invar tapes used by the Coast and Geodetic Survey in its precise geodetic work. Such measurements are carried out in a special underground tape tunnel suitable for tapes up to fifty meters in length (Fig. 1).

The standardizing of high-class weights probably represents the most precise comparison that is carried out in the Bureau of Standards. In comparing two kilogram weights, the weighings can be carried out, if necessary, with a precision of one part in 100,000,000. Such work must be done in a room where the temperature is practically constant. The observer does not stand close to the balance, but reads the deflection of the balance beam through a telescope eight or ten feet away (Fig. 2), in order that the heat of his body may not change the relative lengths of the balance arms by a minute amount or set up disturbing air-currents in the balance case. By means of an ingenious mechanism the observer, without approaching the balance, is able to arrest the balance beam, remove the weights, and transfer them to opposite pans.

The other extreme in weighing is to be found in the Bureau's calibration of the master track-scales and test-cars of the railroads. A special car carrying a hundred thousand pounds of weights is used in this work (Fig. 3). When the Bureau of Standards first undertook the work of calibrating railroad track-scales, the tests showed that only three out of every ten scales tested were correct within the permissive tolerances. A marked improvement has accompanied the inspection, and in 1932 eight out of every ten scales tested were found satisfactory.

The calibration of graduated glassware is another important activity of the Weights and Measures Division. This glassware includes such apparatus as volumetric flasks, burettes and pipettes, which are widely used in precise chemical work. All graduated glassware used in analytical work in connection with prosecutions under the Food and Drug Act must be standardized at

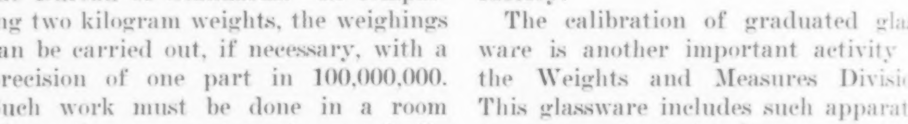


FIG. 3. TESTING RAILROAD TRACK SCALES
EACH LARGE WEIGHT WEIGHS 10,000 POUNDS.

the Bureau, as otherwise the defense will question the accuracy of the analyses. All graduated glassware used by the Customs Service in fixing the revenue derived from sugars and molasses is also tested at the Bureau, as well as most of the glassware used in scientific work throughout the government. Also, vast numbers of dilution pipettes, for use in making blood analyses, are tested for physicians and hospitals and the Veterans Bureau, and numerous hydrometers of various kinds are standardized for the chemical industries.

Testing Engineering Instruments and Mechanical Appliances

Turning now to the work of the Division of Mechanics and Sound, mention must first be made of the great number of engineering instruments and mechanical appliances which are tested annually for various departments of the government and for outside agencies. One of the most important of these instruments is the water current-meter, which is used to measure the volume of flow in rivers and irrigation canals. The essential feature of the current-meter is a tiny propeller which rotates as the water flows past the instrument, while a gear train and an electric contact provide means for counting the number of revolutions of the propeller. Hundreds of these instruments are tested annually for the Geological Survey and the Reclamation Service, and for the Engineer Corps of the Army in connection with its work on the Mississippi River. A special tank four hundred feet long, equipped with a car which travels along the tank at a known speed, is used in calibrating the water current-meters (Fig. 4). The instrument under test is suspended in the water from the car which bridges the tank. The travel indicated by the instrument during a certain time-interval is compared with the distance actually travelled by the car during the same time; this gives the correction to be applied to the instrument at that particular speed.

FIG. 4. RATING TANK FOR CURRENT-METERS

Towing car in foreground.

It will be noted that in the process of calibration the current-meter moves forward through still water, while in actual use the meter is held stationary and the stream flows past it. If the flowing stream were free from turbulence this method of calibration would be strictly rigorous, because the motion of the water relative to the meter is all that is required. Actually, the measured stream is more or less turbulent and some correction may be necessary for the turbulence. This question will soon be investigated in the new Hydraulic Laboratory where large volumes of water can be circulated through the great flume, with varying degrees of turbulence. Practically, it is much simpler and far more economical to move the small meter in a long tank of still water than to move great volumes of

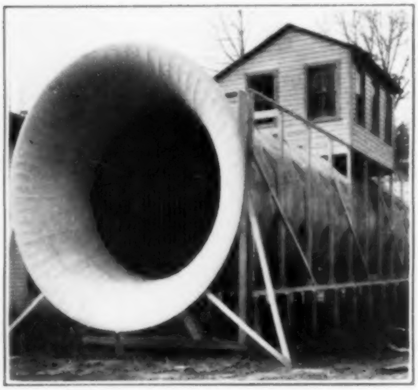


FIG. 5. WIND TUNNEL
ENTRANCE CONE SHOWING HONEYCOMB.

water at a known rate past the stationary meter.

Other tests requiring special equipment include thermostatic valves of various kinds, steam-engine indicators, and pressure gages ranging in capacity from 15 to 5,000 pounds per square inch, or more. Various types of fire extinguishers, including soda-and-acid, foam, carbon dioxide, and carbon tetrachloride extinguishers are tested at the Bureau of Standards before their use is authorized by the Steamboat Inspection Services as acceptable equipment on vessels flying the United States flag. Each lot of extinguishers is held at the Bureau for six months before being tested, because it has been found that some extinguishers deteriorate with time.

Statistics in past years have shown that about three fourths of all fatal elevator accidents result either (1) from opening a door in an elevator shaft when the car is not at that landing, or (2) from starting the car before the elevator door is closed. The United States Government and many states and municipalities now require that elevator doors be equipped with automatic interlocks to prevent such accidents. The success of this measure depends of course upon the reliability of the interlock used. The Bureau has carried out many tests of these devices, one of the requirements being that the interlock shall function 100,000 times in succession without a single failure. During the testing cycle (1) the elevator door is opened, (2) an attempt is made to start the car, (3) the door is closed, and (4) an attempt is made to open the door when the car is (theoretically) away from the landing. All of these operations are carried out by automatic equipment which runs continuously day and night until the test has been completed. It is of interest to note that elevators equipped with interlocks which have successfully passed these tests are granted a much lower insurance rate by casualty companies than elevators not so equipped and protected.

Tests on under-car safeties and buffers (devices to protect elevator passengers in case a hoisting cable should break) are also carried out in cooperation with the American Society of Mechanical Engineers. These tests involve the actual dropping of an elevator (loaded with pig-iron, not passengers) on to the hydraulic buffer under test, which is mounted in the bottom of the elevator pit. Similar tests are made of the under-car safeties, which are designed to grab the guide-rails and stop the car in case its downward velocity exceeds a specified maximum value.

AIRCRAFT INSTRUMENTS

The instrumental equipment of a modern airplane usually includes an altimeter, a tachometer for indicating the speed of the engine, a compass, an airspeed indicator, an artificial horizon, gages for indicating the pressure in the fuel and oil lines, and a thermometer for indicating the oil temperature. All of these instruments should be tested in order that the pilot may have confidence in what they tell him. Work at the Bureau of Standards relating to the testing and development of aeronautic in-

struments is carried out mainly for the Bureau of Aeronautics of the Navy and for the National Advisory Committee for Aeronautics, with the aid of funds provided by these organizations. The Bureau of Standards has developed a number of special instruments for the Navy, several of which are to be found on the new airship *Macon*. One of the most interesting of these is a new type of air-speed indicator which is suspended 50 feet or more below the ship during flight. The instrument resembles a tiny airship about one foot long and carries in its nose a little propeller, which as it is moved through the air rotates at a speed proportional to the speed of the airship itself. This propeller alternately charges a condenser and discharges it through a galvanometer graduated in knots and located in the control cabin. The deflection of the galvanometer is proportional to the number of discharges per second, that is, proportional to the speed of the airship. Instruments of this kind are tested in a wind tunnel where the wind speed can be definitely measured, and are adjusted so as to indicate accurately the true wind speed.

One may ask why it is necessary to suspend an air-speed instrument so far below the hull of the ship. The answer is that the hull of the airship is so large and displaces so much air as it moves forward that it is practically impossible to find any point on the hull (except at the extreme nose) where the airspeed even approximates the true speed of the ship through the air. It is consequently necessary to lower the air-speed indicator to a point below the hull, where the air is not disturbed by the moving ship.

Wind Tunnel Investigations

Another section of the Mechanics and Sound Division is devoted to aerodynamics, *i.e.*, to the study of the forces exerted on bodies in motion relative to the air. The primary tool of the worker in this field is the wind tunnel, a device for creating an artificial wind. It consists essentially of a long tube with a suction fan for producing the windstream, in which the model under investigation is supported from a suitable balance and held at rest (Fig. 5). If the air flow is uniform the forces are the same as if the model moved through still air with the same relative speed. The tube is shaped to obtain as uniform a flow as possible, honeycomb cells being used to straighten the flow. Some ripples are, however, always present, especially small ripples produced by the walls of the honeycomb cells, which cause momentary changes of speed of 1 or 2 per cent. Much to the surprise of the wind-tunnel staff it was found that increasing the magnitude of the ripples from 1 per cent. to 2 per cent. of the mean wind speed greatly modified the aerodynamic forces on the model in many cases. The drag of a sphere at a given speed was more than halved, the

FIG. 6. MODEL OF EMPIRE STATE BUILDING IN WIND TUNNEL

THE WIND TUNNEL FAN IN THE BACKGROUND IS FOURTEEN FEET IN DIAMETER.

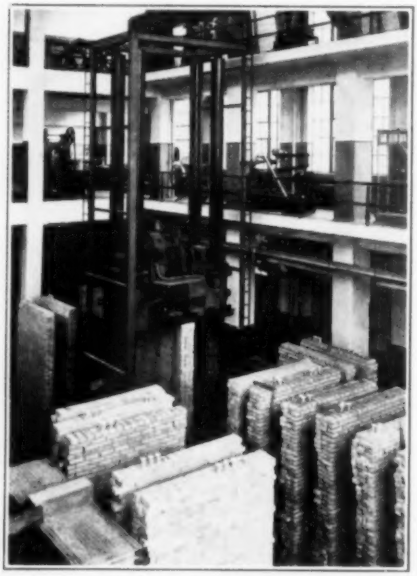


FIG. 7. TESTING BRICK WALLS
WALLS IN FOREGROUND AWAITING TEST.

rate of rotation of a cup anemometer at a given speed was increased several per cent., the maximum lift of an airplane wing was increased. In order to standardize and compare wind tunnel measurements it was necessary to develop methods for measuring the magnitude of the ripples. This was accomplished by the intermittent cooling effect of the ripples on a heated wire, which changes its electrical resistance. The wire used was less than one thousandth of an inch in diameter, so small as scarcely to be visible under ordinary illumination.

Through wind tunnel studies of models of buildings, the Bureau has contributed to our knowledge of the forces exerted on buildings and other structures in high winds. Papers have been published on the wind loads on a simplified skyscraper model, on a mill building, on chimneys and other cylindrical structures, and recently the results of measurements on a model of the Empire State Building (Fig. 6) have been described. We hope to be able to compare these last measurements with observations on the actual building.

Another type of aerodynamic study is represented by an investigation of the performance of fans designed after the pattern of an airplane propeller. These fans are particularly suited for circulating large quantities of air against small pressures. Through the work of the Bureau, technical data are available as to the selection of pitch, diameter and best operating speed, and as to the power required to accomplish any specified result.

TESTING FABRICATED STRUCTURES

The load-carrying capacity of a simple column may be computed with a fair degree of certainty if the length and cross-section of the column and the physical properties of the metal are known. But if the column is fabricated from long steel plates and angles held

FIG. 8. TESTING BRIDGE COLUMN
LOAD IS APPLIED BY A HYDRAULIC RAM BELOW THE FLOOR.

together by rivets or welding, the maximum load which it can carry will depend also upon the method of fabrication, and recourse to testing is necessary. Tests are of special importance if the design of any structure departs radically from existing forms or is unusually complex.

The Bureau has exceptional facilities for studying fabricated structures, and has carried out many tests of this kind. Our largest testing machine has a loading capacity of 10,000,000 pounds and can crush a solid brick wall twelve inches thick and six feet long with ease (Fig. 7). But even this great machine was incapable of testing to destruction the giant columns used in the new Washington Bridge over the Hudson, and special experimental columns were made up for testing purposes in which all dimensions were reduced to one half those of the actual column. Even some of these half-scale columns withstood loads of over 9,000,000 pounds (Fig. 8). Other large-scale tests were carried out in connection with the design of the Philadelphia-Camden bridge. Tests of a model representing a part of the hull of a submarine and fitted with pad-eyes were made for the Navy Department, as an aid in determining the practicability of using pad-eyes permanently attached to the hull for raising disabled submarines (Fig. 9).

Many investigations have been made of the strength and rigidity of airship girders, and other structural members of both airships and airplanes. The strength of welded joints of various kinds, such as are used in fabricating the fuselage of an airplane from steel tubing, has been measured. Similar studies have been made of riveted joints ranging from the light rivets used in aircraft to the heavy rivets used in joining the plates in the hull of a ship (Fig. 10).

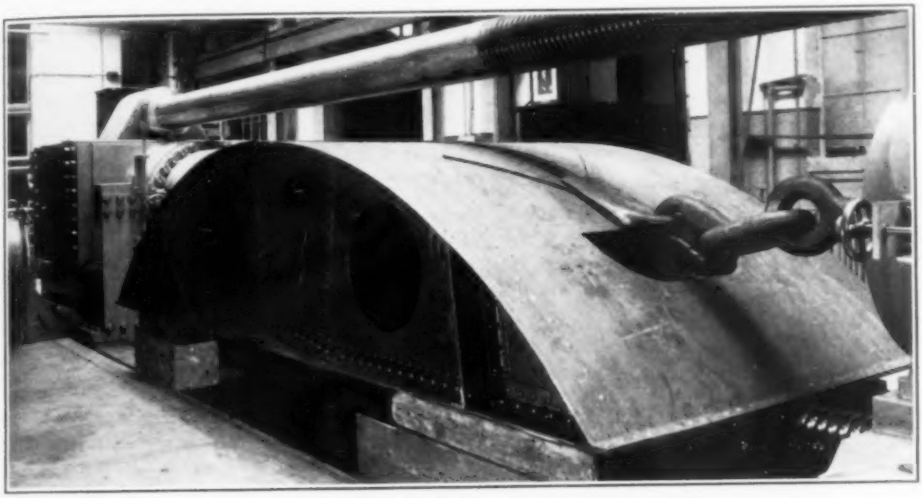


FIG. 9. TESTING SUBMARINE PAD EYES
CURVED STEEL STRUCTURE REPRESENTS SECTION OF SUBMARINE HULL.

In testing fabricated structures it is important to locate those parts of the structure which are stressed most severely under load, for they must be strengthened if the strength of the structure is to be increased. The stress at any point in the structure is determined by measuring the change in the distance between reference lines or gage marks on the surface of the metal. If a

FIG. 10. TESTING RIVETED JOINTS
STRAIN GAGES ARE SHOWN ON THE FACE OF THE STEEL PLATE.

compressive load is applied which does not exceed the elastic limit of the material the gage marks move together by an amount proportional to the load carried by that part of the structure. The Bureau staff has devised some ingenious strain gages for measuring these minute changes in length. The Tuckerman optical strain gage, for example, is capable of measuring a change of two millionths of an inch between gage marks two inches apart. In other words, this instrument will detect the stretch of a steel bar one inch square when it is loaded with a fifty-pound weight.

National Hydraulic Laboratory

The new National Hydraulic Laboratory at the Bureau was authorized by Congress because it was believed that substantial savings would result. It has been found in this country, but more particularly abroad, that experiments with a model of a hydraulic structure provide much information regarding the probable behavior of the full-scale structure, and afford a ready means for determining what changes should be made in the original design before the actual construction is undertaken. In fact several different designs may be compared in the hydraulic laboratory at relatively small expense, and the most effective solution worked out. In the laboratory, the actual structure is represented by a small model made to scale, and the volume of water per second flowing through or around the model is proportionately reduced. Work is now in progress for the Reclamation Service to determine the loss in head resulting from bends in large conduits, and to find the best way of designing the bend to minimize this loss. An effective solution of this problem will save many thousands of dollars annually in pumping charges. Problems concerned with the measurement of water in the field and with the deposit of silt are being undertaken for other branches of the Government. Plumbing systems in high buildings present an unusual hydraulic problem owing to the large volume of air that may be entrapped with the water. It is believed that the hydraulic study of such systems now in progress in the new laboratory will point the way to lower costs and higher efficiency in future designs.

Acoustical Laboratory

One of the most recent activities in the field of sound is the development of acoustic tile and acoustic plasters for reducing the reverberation in large auditoriums, cafeterias, banking rooms,

hospitals and office buildings. A smooth hard plaster is a better reflector of sound than a good mirror is of light. Consequently, when a noise is made in a room with hard plaster walls the sound waves generated are thrown back and forth from one wall to another for several seconds. In other words, we continue to hear what a speaker has said, in addition to hearing what he is saying at the moment.

To correct this difficulty, the walls must be made sound-absorbent, and many tiles and acoustic plasters have recently been developed by various manufacturers for this purpose. In fact, this activity has given rise during the years of depression to a new industry. The immediate necessity for such sound-absorbing materials was brought about by the development of sound pictures. Little attention had been paid to the acoustical qualities of moving picture theaters which were originally designed for silent pictures. But with the introduction of the talking picture, it became necessary to correct the acoustical defects in those theaters, and this required the application of sound-absorbing material to portions of the walls and ceilings. Along with this our people seem to have become more sound-conscious, and a wide interest has developed in the reduction of distracting noise, through the use of sound-absorbing material.

In order to be a good absorbent of sound, an acoustic tile or plaster must be porous. The sound wave striking this porous material apparently penetrates it to some extent and in so doing gives up a part of its energy. The amount of material which must be used in correcting the acoustics of a room depends of course upon the absorption of the material used, which makes it necessary to measure the absorption coefficient of the various sound-absorbents.

The Bureau of Standards has a special laboratory for this work. It consists of a large room with high ceiling and hard-plastered brick walls without windows, and with a single door. Around this room but not touching it at any point except on the common floor slab there is a second similar room, the purpose of which is to protect the inner room from external noises as much as possible. The reverberation of this inner room with its hard walls is truly remarkable. The slamming of the inner door can be heard for 10 seconds or more as the sound waves are reflected back and forth from these hard surfaces with only gradually diminished intensity.

The material to be examined is laid on the floor of the reverberation chamber. Sound of the required intensity and frequency is developed in the room through loud speakers. The source of sound is then suddenly cut off and the rate of decay of the sound energy remaining in the room is measured. This rate of decay together with a knowledge of the characteristics of the empty room suffices to determine the absorption coefficient of the material. A material with a low absorption coefficient is not necessarily less useful on that account. More of it must be used, but in some instances this leads to a better sound distribution.

TRIUMPHS OF EXPERIMENTAL MEDICINE

By Dr. SIMON FLEXNER

DIRECTOR OF THE LABORATORIES, THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

We are used to being told that we are to-day living in a new world. We are even used to being told, just at the moment, that there is doubt whether the conditions of the new world in which we live are better, indeed may not be worse, than those of the world in which our parents and their parents lived their lives.

However that may be, socially or economically considered, there can, I am confident, be no doubt that our state, medically regarded, is far better to-day than in any previous period of the world's history. This fact, for fact it is, as can readily be shown, requires, I feel, no undue emphasis. There is to-day less illness in relation to the population, with fewer deaths and longer expectation of life, than ever before.

But while all this is true and perhaps quite generally known and appreciated, it is not as generally understood as it should be how these great changes and improvements in health have been brought about, and what greater improvements and benefits may be expected in the next period, if the science of medicine is permitted to continue its progress free from the hampering restrictions and obstructions which certain misguided persons would put in its path.

Suppose, for the sake of comparison, that we imagine ourselves back in the year 1870, which in this country was in the period immediately following the Civil War, during which vast experience was gained in medicine and surgery as understood and practised at that time. These experiences, by no means pleasant to contemplate, are described in records and biographies of the hospital surgeons of the time. We shall be transported into a period before bacteriology became a science, and before the amazing discoveries in bacteriology of the Frenchman Pasteur and the German Koch had disclosed the germ nature of wound infection and the contagious diseases, and before the Scotch surgeon Lister, basing his investigations on the discoveries of Pasteur, had introduced antiseptic, soon changed to aseptic, surgery into practise. There are still living a few surgeons who can recall the horrors of those distressing days, when wound infection was rampant, and compare them with the present state of surgical practise, so safe and widely employed that no part of the body, not even the heart and brain, is considered too sacred to be forbidden the exploration of the surgeon's knife. In those earlier days, surgery was limited almost wholly to operations on the surface and extremities of the body; to invade the interior was to invite almost certain disaster; it was to be undertaken only by the boldest and most expert surgeons, and then only when not to operate was even more hazardous than to do so.

All this was changed by the medical research of Pasteur and Lister and Koch in the next quarter of a century. Their investigations, carried out chiefly in the laboratory and at first on animals, provided the scientific foundations for present-day bacteriology and operative surgery, the technique of which has gradually been perfected, extended and taught, until every city and town has the inestimable benefit of the skilled

diagnosis of disease and skilled surgery when needed.

There is no opportunity to deal with details. The knowledge of bacteriology was acquired slowly, and for its acquisition demanded the unremitting labors of very talented men, who succeeded not only through inspiration and effort, but even against much opposition. I have indicated that the discoveries in bacteriology provided the explanation of the sources of wound infection and thus led to the perfection of surgical, operative technique. These discoveries also led to the explanation of the nature of the common infectious and contagious diseases. Just as wound infection results from the presence of one class of bacteria at the site of operation, so do the infectious and contagious diseases result from the presence of particular bacteria within the body.

Those were great days in the last decades of the nineteenth century, which brought to light and opened to experimental study the bacteria producing tuberculosis, typhoid fever, diphtheria and epidemic meningitis, to mention a few notable examples only, and led to the fundamental discoveries in immunity to disease. From the knowledge resulting from these laboratory discoveries we can date those improvements in public health administration which have had so potent an influence in reducing the number of cases and the fatalities of such common infectious diseases as those already enumerated; and, as by-products (and nothwithstanding the fact that their germ causes were revealed twenty or more years later) of measles, scarlet fever and other contagious diseases of childhood.

There is great temptation to introduce figures into this story; but time forbids. I must, however, mention one startling change in the prevalence of a disease formerly so destructive among children. In 1894, before the use of diphtheria antitoxin was introduced, there died in New York City of this disease 4,530 persons, which is at the rate of 163 per 100,000 of population. In contrast to these figures are to be placed those of the year 1932, just passed. In that year there were 212 deaths from diphtheria, or 3 per 100,000 of population.

These are triumphs indeed, the effects of which may be read on every hand in the tables of mortality among infants, children and adolescents, and which in a period of time not too long deferred have led to an increase in the individual expectation of life in the culturally advanced countries of at least 12 years. For a time, this progress if not arrested was at least greatly diminished in speed. The reason was that the improvements in the public health which resulted from the amazing discoveries in bacteriology affected chiefly the infectious diseases of early life, and the extent and safety of operative surgery. The effects of these discoveries and the practical health measures based on them were experienced approximately up to the thirty-fifth to the fortieth year of life. The benefits were thus limited, because the diseases of past middle life present another character and are due chiefly to other causes than those of the diseases of earlier decades.

Just now, and after an interval in which the science of physiology had first to be further built up—precisely as the science of bacteriology had to be developed in the earlier years—progress in the control of disease has been resumed. In this intervening period, physiologists have disclosed the function, or mode of action, of a group of glands of the body, called "ductless" because of their anatomical structure, which had remained enigmas for hundreds of years. The normal action of these glands is essential to the maintenance of health, and

their derangement is responsible, as we have now learned, for serious and fatal diseases as age advances. It is because of the discoveries regarding the nature of the thyroid, adrenal and pituitary glands, and of certain secondary but similar, essential activities of such organs as the pancreas and liver, that increased control is being achieved of certain diseases of past middle life, among which diabetes and pernicious anemia may be singled out for mention. We are in the beginning stages of this advance at the present time; progress is almost continuous at the moment; a bright hope has, therefore, awakened in the hearts of informed physicians and laboratory investigators that the next years will witness a still greater acceleration of the control of chronic disease, compared to which the progress already made, considerable as it is, will appear to have been only a beginning.

Here also are triumphs to be converted into still greater achievements, if the growth of science is to continue unimpeded. You will have perceived that I have omitted to mention still other successes of magnitude in regard to the prevention and cure of disease, which result from the discoveries relating to vitamins, light rays and chemical products or drugs, of which much might be related.

And now, what is it that the experimenter in the laboratory does that has yielded so much already to mitigate disease, improve health and lengthen life, and why is the continuation of his work unfettered by injurious restrictions so essential to further progress? The experimenter studies disease on the lower animals whenever possible, and always under controlled and humane conditions. He seeks to discover the nature of the conditions responsible for disease, just as the chemist and physicist seek to discover by experiment the nature of the phenomena of matter. There are only two ways of learning about things—observation and experiment. For centuries, very learned and gifted men sought to learn about disease from observation alone; the modern medical era which, in spite of its brevity, has triumphed so gloriously over all past eras, has progressed through the employment of the experimental method. By this method, the element of control is introduced into observation; thus it is possible to learn what is happening at any stage of disease and to utilize this knowledge for the understanding and the better management of disease itself.

Great as is the progress of which I have been speaking, there are hard problems immediately ahead to which answers, at least sufficient answers, have not yet been obtained. I have pointed with what I hope is pardonable pride to the decrease in such diseases as tuberculosis, typhoid fever and diphtheria; but what is to be said of cancer, Bright's disease, and diseases of the heart and blood vessels? You all know how seriously prevalent and destructive these diseases are. There is no lack of effort being made to reach a fuller understanding of their nature, origin and control; and I believe that progress is being made. The ultimate goal seems, however, still distant; there is but one way, I submit, to bring that goal within reasonable hope of being reached finally—and that is by continued, unremitting, unobstructed study by the experimental method.

A final word. I seem to have been telling you about disease in man, and I have been. But every essential thing which I have uttered can be applied equally to disease in animals and even in plants. Everywhere in this country are institutions, supported by state or federal funds, in which animal and plant pathology are being studied. The

advances which have so far been made and which are continuing and becoming ever more rapid, have gone hand in hand with the advances made in the study of diseases of human beings. There are no closed compartments in nature into which man, animals and plants can be separately placed. All are related organically and, as we may say, united physiologically and pathologically. A blow struck at experiments to solve disease in man is felt immediately by those who are endeavoring to prevent disease in animals and plants, and *vice versa*. Koch developed tuberculin in the hope that with it he would benefit sufferers from tuberculosis among men; to-day herds are freed of tuberculosis by injecting tuberculin into cattle to disclose hidden foci of disease. The malign operation of mosquitoes and other biting insects in conveying disease germs is the same in principle in Texas cattle fever, in malaria and yellow fever in man and in virus diseases of plants. No essential biological division exists between man and the lower animals and plants, whether in respect to health or to disease. If, therefore, we would learn, and through learning grow more powerful and effective to prevent and to cure disease, to lengthen life and to increase happiness through security in all its varied forms, then we should endeavor to act dispassionately and wisely in promoting the advance in knowledge which alone can free us still further from the evils of disease.

LAISSEZ FAIRE, OR COOPERATION

By Dr. WILLIAM ALBERT NOYES
EMERITUS PROFESSOR OF CHEMISTRY, UNIVERSITY OF ILLINOIS

JOHN MAYNARD KEYNES has characterized the present world crisis as a crisis of abundance and not one of poverty. Millions of men and women are threatened with starvation because we have too much wheat, too much cotton, too much of many of the necessities and luxuries of life for which we can find no markets. Keynes also said, when addressing the School of the Liberal party in Cambridge nine years ago, referring to unemployment already chronic in England, "Such a condition is absurd."

The truth of his statement for the United States is apparent from a comparison of the value of agricultural and mineral products and the value added to raw materials by manufacture in 1900 with the corresponding values in 1930. The value of the production in the United States in these three items increased from $121 per capita in 1900 to $395 per capita in 1930. It is evident that if the people of our country could maintain a reasonably satisfactory standard of living in 1900, it would be possible for them to maintain a much higher standard to-day if the products were properly distributed by giving employment at suitable wages.

It is well known that the industrial revolution of the nineteenth century, which substituted factory manufactures for home products, was developed first on a large scale in England and that she became the wealthiest country in the world. In spite of the vast accumulation of property, however, the industrial development was accompanied by gross injustice to laborers through long hours of work, unsanitary conditions in the factories, child labor, crowding of tenements and in other ways. In England these evils were partially remedied by organization of the laborers and strikes which compelled the owners of the factories to bargain with the workmen on more equal terms. Some of the more flagrant forms of injustice were also corrected by appropriate legislation.

During the '80s, when the thrift fostered in France by the effort to pay the German indemnity led to a period of stagnation in the German industries, there was much political unrest and a threatened revolution. Bismarck, seeing the signs of the times, adopted a part of the socialist program, introducing accident and invalidity insurance and other provisions for the benefit of the working people. The political unrest quieted down and there were no serious difficulties for many years afterwards.

Beginning about 1900, a second profound change in industry has occurred which has been called the "power revolution." This has caused the displacement of millions of men by machines.

At the peak of production of automobile tires shortly after the war a certain factory in Akron employed 32,000 workmen. During the temporary slump which came two or three years later the factory was shut down and the employees were scattered. When the demand for tires revived the production surpassed the former high level, but only 16,000 men were employed.

In 1900 a man in the bituminous coal mines produced 2.98 tons a day; in 1928, 4.78 tons, an increase of nearly 60 per cent. At the same time the average number of days which each man worked in a week in 1900 was nearly five. In 1928 it was a little less than four.

It is reported that after the slump came in 1930 one of our largest steel plants employed a considerable number

of its men in enlarging the plant and installing more modern machinery. The capacity of the plant has been doubled, but the number of men employed before will produce twice as much steel.

Other illustrations might be multiplied indefinitely, but these are enough to show clearly one of the most fundamental causes of our distress. Starving people must be fed, but we should see clearly that to feed the unemployed is only an emergency palliative and that genuine relief must come from the restoration of employment.

Communists are proclaiming widely that the present crisis is a complete collapse of capitalism and that the only remedy is the communistic principle, "Give to every man in accordance with his needs; expect from every man service in accordance with his ability." Russia has already found that a distribution of products without regard to the character of the service rendered is not satisfactory and the principle has been modified in the direction of a return to capitalism in two fundamental ways. Superior performance is rewarded by higher wages or privileges of various sorts. And some supplies are sold at exorbitant prices by other than the usual government agencies. The system has met with very considerable success, however, and seems to have the enthusiastic support of the masses of the urban population. It is very hard to imagine a similar success in European countries or America with their well-developed industrial systems.

The *laissez-faire* doctrine dominated Europe and America during the nineteenth century. It assumes that under a system of free competition the endeavor of each to serve his own interests will lead to equitable prices and to suitable compensation of employees. It failed in both respects. The growth of gigantic combinations of manufacturers in America led to the passage of the Sherman anti-trust law, and the relations of employers and laborers were frequently disturbed by strikes.

The "Power Revolution" has combined with other causes, many of which are direct or indirect results of the war, to produce chronic unemployment in England and Germany and now on a very large scale in America. Against such conditions strikes are powerless unless they include all the workers of a given industry and also include workers who might be transferred from the unemployed of other industries. It was partly a realization of this which led to the "general" strike in England a few years ago. Such a strike is, inherently, civil war between the classes of society and if successful would quickly lead to a condition similar to that caused by a rigid blockade. Such a condition of war would not be permitted to continue by any people. There are four possible conclusions of such a war:

The capitalists may win and establish a dictatorship which will enforce, ruthlessly, a continuation of the old conditions. This was done by Fascism in Italy.

The workers may win and establish, even more ruthlessly, a dictatorship in the interest of the proletariat. This happened in Russia.

A compromise may be reached and previous conditions largely maintained with the unemployed fed and clothed by the rest of the people. This has happened in England.

There is a fourth possibility. This is a whole-hearted cooperation between all classes of society which will result in employment for all, not merely at a "living wage" but at a wage which has some reasonable relation to the service rendered by the individual. The statistics given at the beginning of this article demonstrate that such a condition is now entirely possible.

Whether the wages shall be paid by

an employer controlling capital or by the community is a matter of comparative indifference and depends on whether the community or the corporation can or will render the service most effectively and most fairly to all concerned. We seem to be generally agreed that the post office, schools and roads shall be administered by the community. Water, gas and electric power are sometimes furnished by corporations and sometimes by the community. The telegraph is administered by the community in England and railways and telegraph are owned by the communities in nearly all countries of continental Europe. Refined sugar and steel are entirely in the hands of corporations.

If we accept the thesis that a stable civilization can not long survive with a large class of intelligent citizens unemployed, it is evident that we should search carefully for the causes of unemployment and for permanent remedies. Just as it was found that the principle of *laissez-faire* led to great injustice in the factories and that laws against child labor and regulating the conditions of work were necessary, it is very evident that new legislation is now imperatively needed.

The three most obvious causes of unemployment are: Displacement of labor by machines, decrease in the purchasing power of the people and failure of foreign markets.

The decrease in the purchasing power of the public is due to four important causes; the low prices paid for agricultural products, the cost of the transfer of the products from the farmer to the consumer and failure to lower that cost in proportion to prices paid to farmers, the inability of the unemployed to buy articles necessary to maintain ordinary standards of living and the failure of banks and fall in the price of securities which have impoverished millions of people, rich as well as poor.

The low prices for agricultural products are chiefly due to the overproduction of some staple articles, especially wheat, cotton and corn. A farmers' selling strike can have little effect on such a condition. It may be a question whether large stores of wheat or cotton held for an increase in price may not have an adverse rather than a beneficial psychological effect on the market. If the selling strike could be coupled with a refusal to plant wheat or cotton for another crop and by an increased use of corn for feeding stock instead of for direct sale, something might be accomplished.

Tariffs can be of comparatively little value so long as there is a surplus of the product on the world markets and the production in the United States exceeds the home demand. They may occasionally be of service to exclude Mexican beef or Canadian wheat. It should be remembered, however, that such an exclusion interferes with the market for fruit and for manufactured goods. When the New England farmers could not compete with the wheat and corn raised on the fertile land of the West they were compelled to turn their attention to other crops or to abandon farming. Something of the same sort may happen in relation to Canada and Mexico.

In general, the logical remedy is a greater diversity of agricultural products and a careful study of markets to select the more profitable commodities for production. At this point the Department of Agriculture and the agricultural experiment stations should be able to give good advice. These agencies should help the farmers by giving a broad and careful consideration to the varied economic conditions involved.

The cost of the transfer of the products to the consumer may be lessened by cooperative marketing, with fewer intermediate agencies and by lowering the

cost of transportation. The latter problem must be studied with a fair consideration of the interests of the transporting agencies as well as those of the farmers and consumers.

The most obvious and immediately applicable remedy for unemployment is to shorten the hours of labor from eight to six hours a day or from six to five days a week, distributing the work to be done among a larger number of men. In many cases this would require the men to work in shifts to prevent valuable machines from standing idle. Such changes in the hours of labor have been introduced in some industries and some plants. If corporations will not adopt such measures voluntarily, it may become necessary to make them compulsory.

Persons mining bituminous coal work, on the average, only four days a week. In that and probably in some other industries, a very persistent effort should be made to transfer the younger men to some other industry. Such a policy is contrary to the traditions of the labor unions, but here, especially, the principle of *laissez-faire* has lamentably broken down and modern conditions demand a new treatment of the problem.

As an emergency measure, the day or week may be shortened while the present hourly wage is maintained and the weekly wage is decreased. This is probably necessary because employers as well as employees have suffered tremendous losses during the last three years. It should be remembered, however, that because higher wages are paid in America than in any other country and because 90 per cent. of our products are sold at home, any decrease in the weekly wage curtails in a disastrous manner the market for products. As a permanent policy the weekly wage should be maintained or increased. In the long run the use for the maintenance and increase of wages, of some of the capital which has, hitherto, been used for the expansion of plants, will be profitable for employers. Such a policy is only another step in the direction the world has gone from the time when the 12- or 14-hour day and low wages were common. It is only a few years since the 12-hour day was discontinued in the steel industry.

The displacement of men by machines calls for a different remedy. Machines are evidently introduced to increase the profits of the manufacturer. It would be equitable to require the manufacturer to use a part of the increased profits to pay the wages of the men displaced, for a definite time after they leave the factory. This would give the men an opportunity to find other suitable employment. In Minneapolis the agency administering relief for unemployment makes a psychological study of applicants and endeavors to find work suitable to the applicant's ability. If a manufacturer will continue on shorter hours—*without decrease in the weekly wage,* the men who would be displaced by a machine, the payment of wages to displaced men would not be necessary. Temporary payments to men displaced by machines have been made in a number of cases. Manufacturers who do not see the justice of such payments and who are not willing to undertake them voluntarily might be compelled to make them by law, just as it has been necessary to forbid child labor and enforce restrictions on hours of labor.

It should certainly be possible to prevent, in the future, such an unreasonable number of bank failures as have occurred during recent years. There have been no failures in Canada or England and we should demand of Congress some method for securing the safety of depositors. The statistics seem to indicate that private and state banks are less well supervised and are more subject to undesirable political influences than are the national banks. It is certainly wrong

when the wishes of the depositors of a closed bank are ignored and receivers are appointed by state authorities. Many millions of dollars which should have gone to depositors have gone to receivers who have held political appointments.

During the civil war we were given a safe currency, by requiring any bank which issued bank notes to deposit in the United States treasury government bonds of a value 10 per cent. in excess of the face value of their notes. Sound banks maintain a certain proportion of their assets in the form of liquid securities and close when these assets are reduced to a dangerous point. The necessity for such a provision should be carefully considered by bank examiners, but nothing can take the place of good judgment and absolute honesty on the part of bank officials and intelligent control by the stockholders.

It is estimated that the value of stocks, bonds and securities quoted on the stock market has fallen $80,000,000,000 since the spectacular break in 1929. Our total expenditure for the world war, including $10,000,000,000 loaned to our allies, was only $32,000,000,000. It has been said that the losses were only paper losses and that the real values back of the stocks and bonds remain essentially unchanged. However that may be, millions of our people have been impoverished and the losses have caused a very unjust redistribution of wealth. This is one very important cause of the decrease in the purchasing power of our people.

Several measures are called for to prevent the return of such conditions. The guarantee of the price of wheat during the war carried the market values as high as $3.50 a bushel. This caused a very unreasonable inflation of farm values and many farmers, instead of using their increased income to pay off their debts, went further into debt to buy more land. Some of these have lost all their property.

In a similar manner, corporations, encouraged by an abnormally expanding market, spent great sums in enlarging their plants without proper consideration of the producing capacity of their competitors. A vast amount of capital is tied up in manufacturing plants now idle and which can not, for many years to come, give a reasonable return on the investment. This state of affairs has been fostered by the Sherman anti-trust law, which has intensified the usual secretiveness of large corporations and prevented the knowledge of the total volume of business in their own line which might have forestalled much wasteful construction. It is claimed that the government "plan" of Soviet Russia would eliminate this sort of waste. It seems rather evident that if we can abandon the idea that manufacturers are engaged in a competitive warfare and can establish relations of cooperation and mutual helpfulness between them a much better plan can be evolved than any which could be provided by the government. When such cooperation is permitted and established, some method should be provided to prevent the exploitation of the public by high prices, or of employees by low wages. Under present conditions such protection of the public could probably be best secured by a flexible tariff administered by a commission of experts instead of by a log-rolling Congress. When such a commission found that any commodity was sold at a price higher than was necessary to provide a reasonable return on the actual capital invested—not on watered stock or stock issued on accumulated surpluses—and a suitable surplus to provide for dividends and wages of laborers in slack times, the tariff should be lowered to secure competition from abroad. Genuine cooperation must be cooperation between capital, labor and the public. Some rather ineffective beginnings for such a commission have already been made. The interests of the public should be con-

sidered as well as those of capital and labor.

We can not expect to build up a large foreign trade without lowering our tariffs. An expert commission, with power to obtain the necessary information from manufacturers, could most wisely determine which schedules might be lowered without serious injury.

Not long ago the International Labor Office made a careful comparison of the wages paid in different countries on the basis of their purchasing power. The results were:

United States	197
England	100
Germany	77
France	58
Italy	43

It seems doubtful whether we could maintain the present high standard of living for American workmen if we were to open our markets to the free competition of foreign goods. A sudden change of our policy would certainly be disastrous.

Many corporations doing business all over the country are incorporated under the laws of Delaware, with a very inadequate supervision of their character. There is a crying need for a Federal incorporation act of such a nature as to enforce suitable protection for investors and for the public. There certainly is no excuse for holding companies of public utilities when they are made a means for increasing the rates paid by consumers of water, gas and electric power and light.

Many buildings have been constructed and plants built on the basis of a comparatively small payment by the stockholders and the issue of mortgage bonds covering 80 per cent. or more of the undertaking. It would be better business for those responsible for the enterprise to furnish at least one half of the capital required. This would prevent placing on bondholders the burden of many ill-considered investments. Many such bonds are now "Heads I win, tails you lose." Many other provisions for the security of investments are desirable, but these need not be discussed further.

We are all agreed that the unemployed without financial resources must be fed and clothed and that every endeavor should be made to provide employment by public and private construction of a sort that will contribute to the permanent welfare of the people, such as roads, improvement of parks, reforesting, building of tenements for low rentals to take the place of slums in large cities and much needed school buildings. It is worth while to recall, however, those directions in which unemployment has been relieved during the last 20 years and to think how further progress may be secured.

The automobile industry is a product of the last 30 years. When we think of the thousands if not millions of men who have been employed in building automobiles, in repairing and caring for them in garages, in drilling oil wells and in manufacturing gasoline and oil, we can form some idea of this new line of employment which has absorbed many of the men displaced by the "power revolution."

Incidentally, a great source of enjoyment and increase in the variety of life has been opened up for millions of our people. We can see, here, that the advantages of our prosperity have not been confined to the wealthy but have been shared in generous measure by an increasing proportion of our population. While the three-fold production which has occurred during the last 30 years has given very large fortunes to a few, many have been economically benefited by it.

From the statistics available it seems that there were 630,000 pupils in our high schools and secondary schools in 1900 and 3,345,000 in 1928. There were 224,000 students in colleges and universi-

ties in 1900 and 869,000 in 1928. In both cases there was an increase of 300 per cent. During the same period our population increased about 60 per cent. If the number of students in high schools and colleges had increased only 60 per cent. there would have been only 1,360,000 in 1928 instead of 4,214,000. Assuming that one half of the increase consisted of boys and young men, this means that 1,400,000 boys and young men would now be in the class of unemployed instead of being in schools, if the conditions of 1900 still prevailed. This would have increased unemployment by a very substantial amount.

Here, again, we see that the prosperity of the twentieth century has found its way to a large section of our people. Never before in any land has the opportunity for a higher intellectual life been given to such large numbers of young men and women. Both the automobile and our schools demonstrate that if we can find things which the people want and give them employment the American standard of living may be expanded almost indefinitely. Such things must be discovered in slow detail by men and women who have the vision to see them. Two directions for such discovery may be suggested.

There is a possibility of great improvement in our dwellings in heating, ventilation, conditioning and cooling the air and in decoration and furnishing.

The number of well-trained doctors and dentists makes it possible to organize clinics with staffs which can furnish a good grade of service to people who can not afford to pay the high prices which it is necessary for individual physicians and dentists to charge. The physicians and dentists will make a great mistake if they do not seize this opportunity.

During the first half of the nineteenth century boys and girls on the farms began to do productive work by the time they were 10 or 12 and often earlier. Under such conditions large families were an economic asset. This is no longer true in the twentieth century. Some one has suggested a moratorium on babies as a remedy for unemployment. Certainly parents should not allow their families to increase without careful consideration of the conditions under which the children for whom they are responsible must live.

Communism and Marxian socialism look upon the relations between capital and labor as an irrepressible conflict. Such an attitude is as absurd in a democratic country as the attitude of those Frenchmen and Germans who believe that there is such an antagonism in the character of their races that France and Germany must continue to have recurrent wars.

We have many and difficult lessons to learn before we have fair dealing and genuine cooperation between manufacturers of the same kind of goods, between capital and labor, between teachers and students, between the professional classes and their clients and between politicians and the whole people. When such cooperation comes we shall have put the golden rule into practical effect in economic matters and shall still preserve those opportunities for personal initiative and those high ideals for personal service which are indispensable elements in real progress.

Neither capitalism nor communism can succeed without the acceptance of the golden rule and the development of a spirit of hearty cooperation between all classes of society.

THE PRESIDENTS OF THE UNITED STATES

By Dr. RUDOLF PINTNER

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"THINK of the name of a president of the United States." Such was the stimulus in an association test given by the writer to many students. Perhaps the reader will jot down his response to this stimulus in order to compare it later with the results we are going to give.

The association test in psychology is probably one of the earliest of all tests. It has been used in many different ways and for many different purposes. Its most common use is as a free association test in which the subject is given a stimulus word and is asked to respond by the first word that occurs to him. Hundreds of words have been used in this manner and standards have been obtained for adults and children. If a subject gives very uncommon reactions to a large number of words, he is suspected of being abnormal or peculiar in some way or other. Psychiatrists and psycho-analysts use association tests to discover "complexes" and delve into the subconscious. Association tests are used to help in the discovery of guilty knowledge, on the theory that under great emotional stress the common associations between significant words will be somewhat disturbed. And so the associations have been accurately timed to the thousandth of a second; the same list is repeated a day or two later to check up on inconsistencies; the psychogalvanic reaction for each word is taken; voluntary and involuntary movements of the hands are carefully recorded during the test.

Again, we have the restricted association test where the subject is instructed to respond with the first word he thinks of that falls within a certain category, *e.g.*, an opposite of the stimulus word; a part of the whole represented by the stimulus; a member of the class represented by the stimulus. This type of association test used to be called "a community of ideas" test because it was supposed to show how much alike our ideas are. Various forms of this test have been used in the psychology of advertising, in the exploration of our interests, and so forth.

The interesting thing about the results of all association tests is the similarity of responses made by the subjects. Individuals of similar education, meaning by similar those who have been to high school or college, respond on the whole by very similar words. Certain associations between words form the common currency of thought, despite the peculiar idiosyncrasies of each one of us. We are not so different as we at times would like to believe, in spite of the diverse details of our common environment. What links a certain word to another is due, according to Thorndike, to the habits formed in hearing, reading, speaking and writing. Let us see what are the habitual or common reactions to the stimulus, "Think of a president of the United States."

This stimulus formed one item of an association test given by the writer to many classes of university students since 1925. Let us see which presidents are most frequently mentioned. Will it give us an index of our most important or our most popular presidents? Here are the gross results for 3,186 students. The responses are arranged in order from most frequent to least frequent. The number and percentage for each response is given.

Response	*Number*	*Per cent.*
Washington	784	24.5
Wilson	591	18.6
Lincoln	507	15.9
Coolidge	367	11.5
Hoover	331	10.4
Roosevelt	128	4.0
Harding	107	3.4
Grant	72	2.3
Jefferson	52	1.6
McKinley	45	1.4
Adams	42	1.3
Cleveland	29	.9
Taft	28	.9
Garfield	25	.8
Jackson	23	.7
Monroe	20	.6
Madison	9	.3
Harrison	4	.13
Hayes	4	.13
Johnson	3	.09
Pierce	3	.09
Van Buren	3	.09
Polk	2	.06
Buchanan	2	.06
Hamilton	2	.06
Tyler	1	.03
Fillmore	1	.03
Arthur	1	.03
Grand Total	3186	99.85

Every president of the United States, except Taylor, appears in our list. One non-president, Hamilton, attains the unique distinction of obtaining two votes, thus putting him above three presidents who received one vote each and one president who received none (Taylor). No distinction could be made between the two Adams or the two Harrisons. Both pairs received a very small percentage of the responses. Recency in time is seen in the relatively high positions of Roosevelt and Harding, but Taft comes low in the list. Most noticeable are the relatively large percentages for the first five presidents in our list and the relatively small percentages for all those that follow. The first five presidents obtain 81 per cent. of the responses. The first three alone receive 59 per cent. of the responses. More than half of the responses go to Washington, Wilson and Lincoln. Almost half, or 43 per cent., go to Washington and Wilson.

The names of Washington, Wilson and Lincoln have become associated with "President of the United States" in the minds of educated adults of the present generation much more strongly than the name of any other president; more strongly than the names of the president in office when the associations were made (*i.e.*, Coolidge and Hoover). If the two most common responses had been Washington and Lincoln, the explanation would have seemed obvious and easy, namely, that these are the two most famous of all presidents, and, therefore, are most likely to pop up in our minds when we are called upon to answer suddenly. But with Wilson coming in ahead of Lincoln, this easy explanation will not hold, because most people do not consider Wilson more famous than Lincoln, although some may put him among the first three most important presidents.

Let us now look a little more closely at the effect upon our associations of a president being in office during the time our associations are made. Coolidge was the "reigning" president during the first part of the period when the tests were given, and Hoover during the second part. Obviously, Hoover's position in the list is not to be compared with the rest because he was not yet president. About half of the associations were gathered before he assumed office. From 1925 to 1929, while Coolidge was president, there were 283 out of 1,694 responses for Coolidge, after 1929 only 84 out of 1,492 responses. The number of responses for Hoover after 1929 is 324 out of 1,492. Coolidge has 16.7 per cent. while in office, and then drops abruptly to 5.6 per cent. While Coolidge drops down, Hoover shoots up to 21.7 per cent. "The King is dead. Long live the King." The effect of

holding office, therefore, is to bring the holder well up among the first three presidents on our list, at least temporarily, but not, be it noted, in either case as high as the position of the first President.

The stability of the responses can be studied by an examination of the percentage of responses by years, and also by the cumulative annual percentages from the beginning of the investigation. The yearly percentages are shown in Table I. The years are academic years

TABLE I

PERCENTAGE OF RESPONSES BY YEARS

Year:	1926	1927	1928	1929	1930	1931
Washington	28.8	26.9	28.4	25.2	22.4	19.1
Wilson	21.0	22.4	17.1	16.3	19.9	15.2
Lincoln	16.0	14.8	15.2	18.7	13.8	15.7
Coolidge	14.8	17.7	16.6	12.1	3.3	5.0
Roosevelt	4.8	3.8	3.8	3.2	3.7	4.3
Harding	2.6	2.8	5.7	2.7	3.3	3.5
Grant	3.6	1.1	4.3	1.6	2.8	2.7
Jefferson	1.4	2.0	2.8	0.4	2.0	2.1
Total cases	**642**	**666**	**211**	**564**	**246**	**857**

beginning in September. The year 1926 includes the data collected from September, 1925, to August, 1926, and so for the other years. In this table the percentages fluctuate somewhat from year to year. The total number of cases each year is very uneven. We notice that Washington is unquestionably first each year. Lincoln and Wilson compete for second place from year to year, now one and now the other gaining the advantage. Coolidge remains high until the last two years, when he drops suddenly. Roosevelt and Harding remain fairly steady with a small percentage every year. Grant and Jefferson with very small percentages fluctuate rather markedly from year to year. On the whole, however, the relative constancy of the percentages is the surprising thing.

Table II shows the cumulative percentages for the six years. Here we have the combined effect each year of

TABLE II

YEARLY CUMULATIVE PERCENTAGES

Year:	1926	1927	1928	1929	1930	1931
Washington	28.8	27.8	27.9	27.2	26.7	24.5
Wilson	21.0	21.7	21.1	19.7	19.8	18.6
Lincoln	16.0	15.5	15.4	16.3	16.0	15.9
Coolidge	14.8	16.3	16.3	15.2	13.9	11.5
Roosevelt	4.8	4.3	4.2	3.9	3.9	4.0
Harding	2.6	3.6	3.5	3.3	3.3	3.4
Grant	3.6	1.8	2.2	2.0	2.1	2.3
Jefferson	1.2	1.6	1.8	1.4	1.5	1.6
Total cases	**642**	**1,308**	**1,519**	**2,083**	**2,329**	**3,186**

the total responses made. Washington remains very steady, with a slight falling-off towards the end. Wilson shows an almost continuous slow decline. Lincoln remains quite stable throughout the whole period. Coolidge holds up well because of his initial large number of votes during his term of office, but the decline begins to show towards the end. Roosevelt shows the same type of stability as Lincoln, except that the percentage of votes is much smaller. The remaining three presidents show surprising stability considering the relatively small number of votes upon which the percentages are based.

Educated Americans respond most frequently by thinking or writing "Washington" to the stimulus, "Think of a president of the United States." This response can readily be explained by the forces of habit. From early life they have been accustomed to think, read, speak, hear of Washington as the first president, the most important president, the greatest president and so on. This response occurs with surprising uniformity in about 25 per cent. of cases in any large group. Coming now to the next most common response, namely Wilson, the explanation is not so obvious. In no sense has Wilson been linked up with the presidency of the United States in the same historical fashion as Washington and Lincoln. And yet with the present generation of

university students his name occurs more frequently than that of Lincoln. Do we have here the influence of affective tone? Wilson is, for the present generation, a man with reference to whom each one of us must "take sides." One must be either for him or against him. People still love, venerate, extol him, or else hate, vilify, execrate him. About 20 per cent. of educated adults react in this way. The gradual decline in percentage in Table II from 21 to 18.6 may be an index of the decreasing emotional tone surrounding Wilson. With reference to Lincoln, the same type of explanation would seem to hold, as with Washington. He is one of our most famous presidents, with an assured historical position. Coolidge shows the effect of holding office and losing office.

The last four responses in Tables I and II all show much smaller percentages, but it is interesting to note the stability of all four of these responses. No one could have guessed that these four presidents, Roosevelt, Harding, Grant and Jefferson, would have appeared after our most popular ones. Recency may explain Harding and Roosevelt, but not Grant and Jefferson. And if recency is a factor, where is Taft? Popularity or enthusiastic acclaim may still surround Roosevelt, but certainly not Harding. Historical importance is a possible explanation for Jefferson and perhaps for Grant, but certainly not for Harding and probably not for Roosevelt.

It would seem, therefore, that the factors governing our associations to such a stimulus as "Think of a president of the United States" are very diverse. No simple single explanation is possible. Habit or frequent use in the past seems most important, but contemporary happenings (the president in office now) come in to influence us. The emotional tone surrounding a name may have some influence. Recency, in the sense of having been a president in the recent past, seems to have some little influence. Greatness, in the sense that Washington and Lincoln were great, seems of itself, divorced from habit and use, to have little influence, as witness the small percentages for Jefferson and Adams.

Perhaps the most striking thing about our little experiment is the stability of the results. Year after year, in class after class of students, almost the same percentages of responses appear. Individuality or eccentricity of response is rare. Our thoughts move along in an orderly predetermined manner.

SHALL WE MOVE TO THE COUNTRY?

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I

THERE was a time when a man, asked why he lived in a great city, might reply that he did so because in the city he could earn a living. The noise and dirt and rush of the city he freely admitted, but in the end none of these weighed against the higher wages that he got or hoped to get from the mills and stores and offices that swell the city's bulk.

To-day, when so large a proportion of the working populations of all great cities are unemployed, the economic argument loses much of its force. Slowly it becomes apparent that some things are even more important than money, important though that may be, and that possibly they may be found more easily in the country or the town than in the city. The city is draining back into the country, where there is still wood in the forests for fuel and where there are gardens that will produce food. It may be for the most part an unwilling involuntary exit, but there are also those, both in the city and outside it, who have been driven by their circumstances to an intelligent casting up of accounts, in the effort to decide after a frank survey of the facts whether the tide ought ever to be reversed and the cities resume their mushroom growth of the last century.

Some of those factors have rarely been taken by the city dweller as of prime importance, and yet they are absolutely essential to life in the city or elsewhere, without which life itself is impossible. They lie at the base of all the studies of the biologist and the medical man. They do not conflict with a normal social appetite, for it must be recognized that men, like all other animals, must live together if life and the race are to be continued. Nevertheless, it is a question whether, in the case of the great city, this innate social drive has not been stimulated past the point of usefulness.

Reduced to the simplest terms of living, men must still have an adequate amount of air or oxygen, food and water, and in temperate and cold climates some protection against the cold. There are also related conditions, such as the humidity of the air, light, pressure, which includes such widely differing factors as osmotic pressure and wind movement, and the character of the ground under our feet, that must be taken into account. In so far as these requirements are most fully met, existence becomes least precarious for men.

Many of these conditions necessary for life normally shift between extremes. Light, for example, fluctuates from that of a bright noonday in summer to the dark of a moonless midnight, and there is good evidence that such variation is stimulating and desirable. The twenty-four hour Arctic summer day might play only less havoc with our civilization than a continual Arctic night.

On the other hand, there must be certain stabilities. A fairly rigid earth crust, not too frequently shaken by earthquakes, is necessary; and even more important than this is a climate that is not too severe or subject to rapidly repeated changes. Many abnormal elements of an environment can be endured if not too extreme or constant. An occasional bitter snowstorm or heat wave is not of serious damage to the people of the temperate regions.

It is a curious thing that apparently the great cities of the world are located

first by their requirement of a certain favorable climate, and only secondarily and within that range by such factors as natural harbors, railroad centers and the nearness of raw material for manufacturing.

Further, the favorable climates are different for different races. Griffith Taylor, English - Australian - American geographer, lists as twelve typically located cities of the white race, London, New York, Berlin, Chicago, Sydney, Perth, Hobart, Capetown, Johannesburg, Aberdeen, Toronto and Seattle. Seven are in the northern hemisphere and five in the southern, but the climates of all are, in general, similar; they show a rather high humidity and not too severe temperatures, though inclined toward rawness rather than mildness. The colored races, either yellow or black, appear to adapt themselves better to another type of climate, and their great cities, such as Calcutta and Shanghai, have grown up under conditions of greater heat and still higher humidity.

Our own great cities do not rise in severe climates, but the studies of another geographer, Huntington of Yale, show that too great constancy of climate is also undesirable. The much maligned, changeable weather of New England is definitely more stimulating to workers, at least those of the white race, than is the more agreeable climate of our Southern States, or of the Hawaiian Islands. The greatest voluntary effort appears to be put forth following small, not too severe changes in weather; and our big cities have grown up in climates which provide these constant changes. It seems unlikely that even by taking much thought they could have been successfully located elsewhere.

It is a pity that, as if to nullify the natural climate, we tend more and more to control weather conditions within the house to one dead level, and to spend more time in these artificially created conditions. This tendency is general, but the city man is at once the greatest sinner and the greatest sufferer from the high temperatures and low humidities of the common American practise of house heating.

Humidity is one of the essential factors of life to which little effective attention has been paid. Huntington's studies show that, other conditions being equal, low humidities are definitely harmful.

As proof, he has gathered together information on the death rate in surgical operations in a given city with regard to the humidities at which most deaths occur. Surgeons may be supposed not to operate unless there is hope of the patient's recovery; and post-operative care is presumably as good under one humidity as another. Nevertheless, he has found that in Boston, for example, the highest death rate following operations occurs at 25 per cent relative humidity, when the air is very dry; the death rate is distinctly lower at a relative humidity of 97 per cent, when the air is practically saturated; it is lowest of all at the medium value of 57 per cent.

A study of deaths from non-contagious diseases with relation to the humidities at which they occur is also interesting. In more than a millon such cases in the United States in 1912–15, Huntington found that there was a definite tendency toward higher death rates during lower humidities.

II

The matter of climate, whether of his general geographical area or the little climate that he creates in his house, has not yet struck the city man as particularly important to him; the concessions he makes to it are largely unconscious; but experience, often very costly of life, has impressed on him that safe water he must have.

A city water supply that will not cause disease must either be secured

from some territory far removed from human habitation, such as the New York upstate reservoirs, or be freed from the germs of disease by some artificial means. This is expensive, but it is not so expensive as polluted water.

In small cities deep wells serve the purpose, in which case the water has traversed a natural filter that removes disease germs. Water from rivers can be purified by filtration that roughly resembles the natural process. In some cities favorably located near a large lake, as Chicago is, the addition of chemical purifiers may render the water safe, though not necessarily pleasant to the taste. When the chlorine is strong in the tap water, those Chicagoans who can afford it buy bottled spring water.

Nevertheless, in spite of the taste, Chicago water is safe, and the history of its supply is as striking an example of the effect of water upon health as can be found. Before the course of the Chicago River was changed, carrying its sewage-laden water away from, rather than into Lake Michigan for the city to drink, the typhoid death rate per 100,000 of population was nearly 200 annually, while now it is under 1.0. Based on the city's present population, this means the prevention of seventy thousand cases of typhoid fever and seven thousand deaths from this cause annually.

Provision of an adequate supply of safe water for a large city has long since ceased to be a private concern, but has been relegated to the health department, as has also provision for sewage disposal. Sewage may be mixed with a relatively large amount of water and emptied into flowing streams, in which case it is certain to be a nuisance to cities farther down the course; or it may be emptied into the ocean where it will not only be a nuisance to neighboring beaches, but may return on the tide to plague the city from which it came. It is probable that the nuisance and the fouling of places of recreation is greater than the real harm occasioned. At greater expense, to which the cities are slowly being pushed, sewage may be more satisfactorily reduced by bacteria and oxidation in tanks or filter beds constructed for the purpose.

It must be noted that the sanitary index of the great American cities, which is judged largely from the typhoid rate, is materially superior to the average of rural districts. This problem, partly because it was so acute, has been solved and may be placed to the city's credit.

III

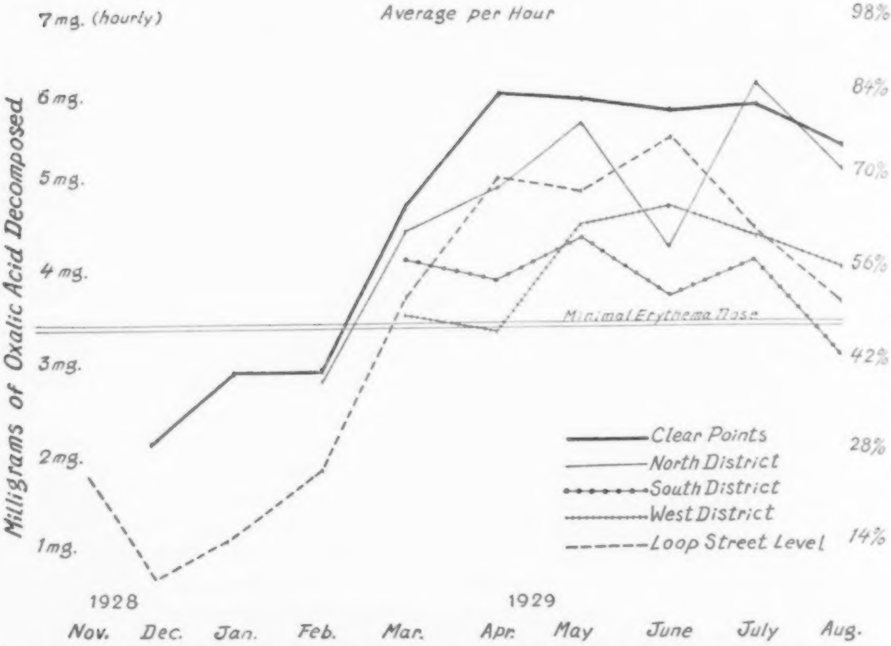
A third essential, good air, is not so easily come by in the city. The city man may breathe and exist, but the coal-black lining of his lungs tells a story of air pollution that passes beyond the stage of mere dirt, for which he may or may not have an esthetic distaste.

Inside and outside of factories and mills the smoke and dust create a problem with which no city has successfully dealt, and even in residential sections of the city where soft coal is burned in furnaces the smoke pall is apparent.

This has its direct effect in increasing respiratory diseases; but there is a more important and undesirable effect of the smoke cloud: on its tiny particles moisture condenses to form fogs, and between the smoke and the fog not only the famous thick choking "London fogs" are formed, but one gray day after another dims the city.

Not only is half the available visible sunlight cut off, so that artificial light must be used, but the effective and useful ultra-violet radiation is also eliminated. Chicago suffers a great loss of these beneficial rays of short wavelength during most of the year; in the winter months no ultra-violet of physiological value reaches the people in its streets.

Other cities show similar effects. Baltimore loses half the amount of



AVERAGE INTENSITIES OF ULTRA-VIOLET RADIATION FOR FOUR CHICAGO DISTRICTS AND FOR ESPECIALLY CLEAR POINTS WITHIN THE CITY. THE DATA WERE COLLECTED IN HOURLY OBSERVATIONS BETWEEN 11 A. M. AND 3 P. M. FOR THE MONTHS AS INDICATED. (FROM TONNEY AND DELONG, 1931.)

ultra-violet which it might receive. Pittsburgh has an especially evil reputation in this regard. In that city an intensive program of smoke abatement has reduced the visible smoke over the city, but has increased the total air dust by 40 per cent. This finer air dust, the result of forced draft combustion, is less opaque to ultra-violet than is the same amount of soot and black tarry smoke, but the increased load which the air carries would seem to offset approximately any advantage gained by more complete combustion, in so far as its penetration by ultra-violet is concerned.

The effect of cutting off health-giving ultra-violet radiation from the city is the more serious since it occurs in the winter months when there is the greatest tendency to stay out of the fresh air, cooped up in the stagnating temperatures and low humidities of city buildings. The whole sum of winter behavior results in an increase of the death rate, accidents aside, in the winter, as contrasted with the summer and particularly late summer.

But even in the summer Chicago may be seen from an airplane to lie under a vast cloud of gray smoke. This may be alleviated by modern methods of combustion, but it is doubtful if it can be entirely eliminated, even with the best will to do so, while soft coal is consumed. Some cleaner form of heating, probably more expensive, will be necessary before the city child can receive the all-year-round dosage of ultra-violet rays that will insure him good straight bones and high immunity to disease, or the city worker enjoy the greatest health and vigor.

The great number of automobiles on city streets present us not only with our rising quota of accidents, but also with another source of air pollution. It

is a well-known fact, though still overlooked at times, that garage doors must be left open when an automobile is running in order to avoid the deadly effects of exposure to the tasteless, odorless, invisible gas, carbon monoxide. It is not so well known that long exposures to low concentrations of carbon monoxide gas may produce as severe results as shorter exposures to higher concentrations, and that such an exposure may occur in the open air of a street of heavy traffic. In a study of the carbon monoxide content of the blood of fourteen traffic policemen of Philadelphia, six showed a concentration of 20 to 30 per cent., which, while not enough to cause death in an adult, was sufficient to bring on serious symptoms of dizziness, headache and nausea.

In a survey of the distribution of carbon monoxide in Chicago streets, reported in 1928, the samples of air were collected, not at the center of the street, but at the curb, and not at the ground, where the concentration is greatest, but at the level a child would breathe, about three feet from the ground. Under these conditions a concentration along automobile boulevards was found sufficient to be a danger to the health of persons exposed to its action over a period of several hours, with an increased danger to any person who might be muscularly active and hence breathing rapidly and deeply. The air of the lower level of Wacker Drive, a double-decked street fronting on the Chicago River, was found to contain 0.62 parts of carbon monoxide in 10,000 parts air; the streets of the Loop averaged a sixth less and the boulevards slightly less than that. On this evidence the Chicago Department of Health refused permission for the taking of air from the lower level of Wacker Drive for the artificial ventilation of neighboring office buildings.

IV

Fresh vegetables, fruits and other perishable foods are brought into the city by transportation and refrigeration so good that the city family of moderate means is supplied at all times of the year with a larger variety of food than can be obtained in many rural communities.

Milk, which forms as ideal a food for bacteria as for babies, has been responsible in the past for many outbreaks of typhoid, dysentery, scarlet fever, diphtheria, septic throat and tuberculosis. Health departments have dealt with its difficulties so ably that the city family is assured of at least as wholesome a supply as if it kept a cow.

Commercially canned foods, which form an increasing part of the city diet, are put up under conditions that insure their healthfulness. The raw products going into canned foods are selected at a time when they are thoroughly ripe and are packed under the best conditions and at the temperatures most favorable for the preservation of all the food elements, including the vitamins, many of which are preserved to a greater degree than when the same food is cooked at home in an open kettle with free access of air. There is much less danger of food poisoning from canned food than from uncanned, especially than from warmed-over food.

As with water, superior food is to be had in the city, but at much greater relative expense.

V

The physiological importance of noise is not realized, or the noises that are avoidable would scarcely be tolerated.

An ingenious measuring unit for noise, called the decibel, has been worked out. On this scale zero represents the lack of noise in a specially constructed soundproof room; one represents the sound volume just audible to human ears in such a room; ten represents ten times that amount of noise, as measured by a mechanical device and each succeeding major point on the scale represents the effect of multiplying the preceding value by ten, so that the scale is

NOISE LEVELS OUT OF DOORS DUE TO VARIOUS NOISE SOURCES

DISTANCE FROM SOURCE	SOURCE OR DESCRIPTION OF NOISE	NOISE LEVEL	SOURCE OR DESCRIPTION OF NOISE	NOISE IN POWERS OF TEN
FEET		DB		
		130	THRESHOLD OF PAINFUL SOUND	10^{13}
		120		10^{12}
2	HAMMER BLOWS ON STEEL PLATE-SOUND ALMOST PAINFUL (INDOOR TEST)		AIRPLANE; MOTOR 1600 R.P.M.; 18 FT FROM PROPELLER	
		110	AERO ENGINE UNSILENCED-10 FT.	10^{11}
		100		10^{10}
35	RIVETER			
15-20	ELEVATED ELECTRIC TRAIN ON OPEN STRUCTURE	90	PNEUMATIC DRILL-10 FT. NOISIEST SPOT AT NIAGARA FALLS	10^{9}
15-75	VERY HEAVY STREET TRAFIC WITH ELEVATED LINE	80	HEAVY TRAFFIC WITH ELEVATED LINE, CHICAGO	10^{8}
15-50	AVERAGE MOTOR TRUCK		VERY NOISY STREET N.Y. OR CHICAGO	
15-75	BUSY STREET TRAFFIC	70	VERY BUSY TRAFFIC, LONDON	10^{7}
15-50	AVERAGE AUTOMOBILE			
3	ORDINARY CONVERSATION			
15-300	RATHER QUIET RESIDENTIAL STREET, AFTERNOON	60	AVERAGE SHOPPING ST, CHICAGO BUSY TRAFFIC, LONDON	10^{6}
15-50	QUIET AUTOMOBILE	50	QUIET ST. BEHIND REGENT ST. LONDON	10^{5}
	MINIMUM NOISE LEVELS ON STREET:			
15-500 50-500	NEW YORK DAY TIME — MINIMUM AVERAGE			
		40		10^{4}
50-500	MID NEW YORK NIGHT — MINIMUM			
		30	QUIET ST, EVENING, NO TRAFFIC SUBURBAN LONDON	10^{3}
		20	QUIET GARDEN, LONDON AVERAGE WHISPER - 4 FT.	10^{2}
		10	QUIET WHISPER-5 FT. RUSTLE OF LEAVES IN GENTLE BREEZE	10^{1}
		0	THRESHOLD OF HEARING	10^{0}

made up of successive powers of ten. These powers of ten have been named decibels; 50 decibels represents a noise energy 100,000 times that of the threshold, in mathematical terms 10 raised to the fifth power.

On such a scale a quiet country house has a noise value of 25 decibels; a quiet city street, 50 decibels; a noisy New York or Chicago street is a thousand times noisier than a quiet street, and an airplane engine produces a noise a hundred times greater than that of a noisy city street.

This is more easily realized if translated into human terms. The average street noise of a normally busy New York street is said by Dr. E. E. Free to make the average person on the street one third deaf; that is, he hears only those tones that a person one third deaf would hear. The noisiest streets render the average person half or even two thirds deaf while he walks among them; the city noises at night cause about one tenth to one twentieth deafness. Any one personally acquainted with the fatigue of partial deafness can translate these statements into still more intimate human values.

In general these city noises are all "necessary" products of our systems of transportation; over 90 per cent. of all the noises at a busy New York corner

were produced by traffic. Trucks accounted for 40 per cent., the elevated railway for 25 per cent., street cars 20 per cent., and, of the remaining 15 per cent., a fair share was produced by private automobiles.

It is interesting to find that a person finds a noise less irritating if he regards it as necessary; the effect varies with the person concerned, and it depends on the pitch as well as the volume of sound; but all noises appear to have some physiological effect.

It requires more nervous energy to do the same work in noisy than in quiet surroundings, even when talking is not required, and if speech is necessary it frequently happens that a very great deal more energy is required. Dr. Laird, of Colgate, has demonstrated that there is an average saving of about 20 per cent. in the energy of typists working in a quiet, as contrasted with a noisy office; and the best typists are those most hindered by noise. For these, moving to a quiet working place would be the equivalent to taking a partial vacation.

Sudden noises affect pulse and breathing and muscular response, and send up the pressure of the blood and the cerebral-spinal fluid; and the effect is greater if the person under observation is already in a state of tension; even the focusing of attention on a picture will increase the response to noise. It is perfectly clear that the continual contacts of city life, the strain of crossing traffic-filled streets, and the assorted worries produced by city competition make relaxation a rare luxury, and provide a tension that increases the harmful effects of noises and other shocks.

Noise abatement engineers can do much toward deadening unnecessary sounds, as the automobile muffler bears witness; they have invented window devices which admit fresh air without allowing street noises to pass, and wall-lining materials which effectively absorb sound inside buildings, but the expense is so considerable that these are not likely to come into general use very soon.

VI

Despite the cool dark depths of its great buildings the city is hot in summer. Out of doors the masses of brick, stone, cement and asphalt either reflect the heat directly, thus adding to the immediate discomfort of the sun's warmth, or absorb and store it up to radiate it again at night. The city buildings block the free sweep of the night breezes, and the night is only less warm than the day.

In the woods the coolness of the shade is due to the lack of direct sunlight and heat, and it is augmented by the fact that the leaves of the trees are filled with watery sap, so that about a quarter of the summer heat falling on the leaves is dissipated in evaporating sap. In the structurally shaded city there is little or no such protection from the full heat of the sun.

The higher city temperatures are more important from the point of view of health than is indicated by the mere discomfort that they produce. There is strong evidence that infant diarrhea and other intestinal disturbances are increased by high temperatures. It may be that through the hot spells adults are slacker and less carefully clean, but there is good evidence to suggest that the child's difficulty in adjusting to long hot days and nights is a predisposing cause for these particular diseases. The 1918–1920 deaths of children in the United States registration area show that there were almost 50 per cent. more deaths from these diseases among city children than among those in rural regions.

VII

The city dweller is constantly in intimate contact with others, some of whom are suffering from contagious diseases. He is thus exposed in childhood to many diseases with which his country cousin

may not come in contact during a lifetime. Contact with other individuals is the chief method by which diseases are transmitted, rather than by any contact with bedding, clothing, furniture or dust and air. It is well known that individuals, called "carriers," may harbor germs causing such diseases as diphtheria, typhoid and meningitis, though they themselves are not ill. Attempts are constantly and successfully being made to lessen these dangers. More and more we are throwing the responsibility of prophylaxis upon delegated authorities, who administer quarantine regulations, examine school children at frequent intervals, conduct educational campaigns and, when necessary, give free vaccination, toxin antitoxin, anti-rabies treatment and protective serums. With the complete cooperation of the public several of these diseases could be wiped off the list completely with the knowledge and means at hand.

One of the most important diseases more common in the city than in the country is tuberculosis, though in Illinois, for example, in the last twenty years, the death rate from tuberculosis has decreased more rapidly in the city than in the country districts.

Poverty, and the crowding, poor ventilation and deficient food that go with it in the slums of the great cities, has doubtless accounted for the difference here between city and country. The vital connection between income and tuberculosis death rate is startlingly told in the following table, compiled from German statistics, but equally applicable to other countries in the temperate zone.

Taxable income	Number of persons	Death rate per 100,000
900–1200 marks	71,526	482
900–2000 "	48,855	447
900–3500 "	21,397	274
900–5000 "	8,342	252
Over 5000 "	14,323	120

Tuberculosis has been vigorously combated by cooperating federal, state and municipal organizations, with the result that the death rate from that cause in the United States has been more than cut in half in the last hundred years. Whether the greater poverty of the last three years will cause the curve to rise again it is too early to tell, but if it does the effect will probably appear first in the city.

Pneumonia and diphtheria are usually much more prevalent in cities than in the country, as is enteritis among children; whooping cough takes a lesser toll, probably on account of more careful quarantine. Venereal diseases are said to be much more prevalent in the city, though this is a statement difficult to check from facts. It seems fairly plain that the greater difficulty in finding wholesome amusement in our densely populated areas tends to favor opportunity for venereal contagion.

Rabies is also commoner in the city. It is a disgrace to modern civilization that a disease so readily controlled by the simple device of muzzling dogs when on the street, should still take a high annual toll of life. Man and dog have always been closely associated and the tie is hard to break, regardless of the fact that the city is no place for a dog, whatever it may be for his master. With so many people and dogs in a limited area it is small wonder that dog bites are frequent and rabies not at all rare. In England the effect of enforced muzzling of dogs has been clearly shown. Rabies was entirely extinct in England until some misguided humane society workers succeeded in getting the muzzling laws repealed. Rabies again appeared and increased until the laws were again put into effect, when it again became extinct.

Dogs and cats not only carry rabies, but harbor fleas and other vermin, and fleas carry the plague; parrots transmit psittacosis, and rabbits tularemia. It may well be questioned whether the

enjoyment derived from pets is not overbalanced by the health hazard they introduce. In the country the dog may be a very useful or almost indispensable helper, and the greater freedom that he can enjoy reduces to some extent the health hazard; under the artificial conditions of the city he is likely to go from a forlorn and restricted puppyhood through a short life of distemper and indigestion, and end as a limp heap knocked aside by some passing automobile.

The keen competition characteristic of the city, the struggle to exist and to maintain social or financial position results in a number of abnormal physical conditions. This incessant drive, made more serious by noise, crowding and lack of sufficient sleep, is partly to blame for the increased numbers that show high blood pressure, heart and other degenerative diseases. It also accounts for the greatly increased number of suicides and mental derangements, as well as being a factor in family difficulties of all degrees of seriousness. The cases that are definitely mental have been to some extent provided for; the problem of prevention has hardly been touched.

And to the list of city dangers must be added traffic and industrial accidents, and the industrial hazards of dust and heat and poison, for which a whole new department, that of industrial medicine, has been set up.

There is no question but that the best medical and hospital care may be had in the city, especially in those cases in which cost is no consideration. This fact may paradoxically increase the apparent death rate of the city, since the most serious country cases are often sent to the city hospital for treatment, where they may die and swell the city's mortality records.

It must be said, however, that it is not easy for the newcomer to the city or the person without previous experience in illness to find proper medical care. The country family usually knows personally or by hearsay all the doctors in a wide neighborhood and can select from among them intelligently. Not so the city dweller. The neighboring doctor, for anything he knows, may be good, bad, indifferent or even a quack; he may charge fees too high for this particular patient, of whose financial ability he knows nothing; or the prospective patient may delay getting the attention he needs because of his fear of bills beyond his ability to pay. If he is without funds he finds it equally difficult to know where to turn for medical advice.

In metropolitan Chicago there are between three and four hundred health agencies, from which the patient may select services. Many of these are overlapping or specialized. Who is to tell the stranger where to turn? The organized medical societies will not give the information for fear of showing favoritism. The health department will refer the inquirer only to charitable organizations.

It is partly for this reason that many seek the great organized clinics, connected with hospitals and medical schools, where they feel a reasonable confidence in receiving good care at a reasonable cost. The increase in such group practise, with a hospital as a center, seems to be the best practical solution of this problem, which is vexing both to the patient and the doctor. It gives an opportunity for the doctor to maintain his initiative and independence, but with consulting aid at hand, and with the least expenditure of time and money on the part of the patient.

VIII

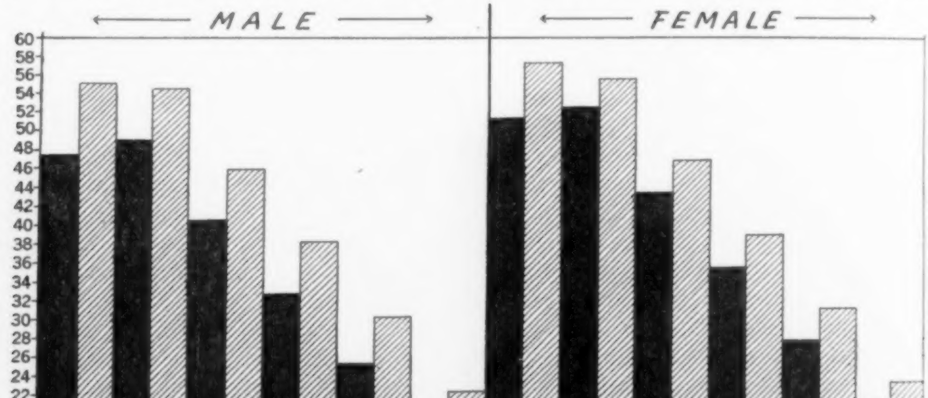
There are certain long-run considerations that should be taken into account in this summing-up. The relation between the density of human population and the human death rate has long attracted attention. A law formulated by an Englishman, Farr, states that the

death rate rises directly with the density of population in a given area, when due account is taken of the laws of general sanitation.

This law was first stated for certain regions in England in 1861–70 and was found later to hold for the same regions for the decade of 1891–1900, with the exception that on account of improved sanitary conditions similar densities of population had only about nine tenths of the effect that had been shown in the 1860's. The populations investigated ranged from 166 to 65,823 persons per square mile, which even at the highest is a relatively mild degree of crowding. In the densely crowded districts of New York there are 224,000 persons to the square mile.

The significance of the facts underlying this law may be partially grasped when it is seen that according to United States census figures in the registration of 1910 there were 1,590 deaths per 100,000 population, as compared with 1,390 deaths in rural districts. The corresponding figures for 1920 are 1,411 for urban and 1,194 for rural regions. There is evident improvement in both during the ten years in question, with more rapid improvement in the city districts, but even if the same rate of improvement were to hold for our children's and our grandchildren's generations the country would still show a lower death rate than the city.

The city holds the advantage in infant mortality, and as we have seen, in typhoid and some other contagious diseases, but against this showing must be ranged the fact that in 1920, of the fourteen principal causes of death, not including accidents, only one, typhoid fever, showed a markedly higher rural than urban death rate, and only one other, cerebral hemorrhage, was at all higher in the country. Not even the stream of country patients to city hos-



LIFE EXPECTANCY FOR 1910 IN THE ORIGINAL REGISTRATION AREA OF THE UNITED STATES. (DATA FROM U. S. CENSUS LIFE TABLES).

pitals could wholly account for this difference.

Life expectancy tables, compiled from census figures for the original United States registration area, tell the same story even more strikingly. A boy born in 1911 in the country, and remaining there throughout life, had on the average a right to expect to live 7 years, 9 months and 19 days longer than if he had been born and lived in the city. A young man twenty years old in 1931, born in the city and living in a city thereafter, would at the present time have a life expectancy of some five years less than if he had been country born and bred and remained in the country his whole life. With women and girls there is a shorter spread between city and country life expectancy, but the same general relations hold.

Another interesting consideration in the long run is the apparent effect of the city on child-bearing. The ratio of children under four years to women of child-bearing age (20 to 44) is lowest in cities of a hundred thousand and over. In the United States, for native white women, there are in the larger cities 341 children below four years of age for every thousand women of twenty to forty-four years of age; in smaller cities of two thousand to ten thousand population the number of children rises to 477; and in rural districts as a whole the ratio stands at 721 children per thousand women, which is more than double the city ratio.

Among foreign-born women, whether rural or urban, there is a tendency toward a larger number of children, and the foreign born of recent immigration show a higher ratio than those who migrated earlier; but there is always the same difference between country and city, no matter what the stock.

The effect of city living upon reproduction is most marked among Negroes. In Northern states, where most Negroes are urban, they show a much lower birth rate than the whites of the same region; in Southern states, where most of the Negroes live in the country, the rate of increase is about as high as that of the native white population.

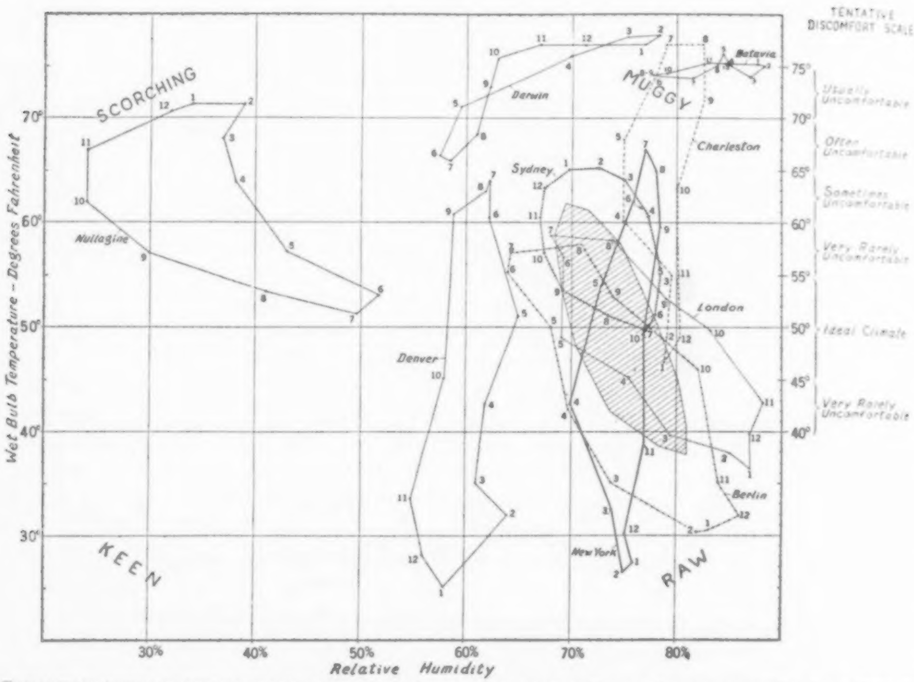
IX

Certain benefits of city living not recorded in the census must in fairness be placed to the city's credit. A foreigner must usually go to the city if he is to find a group of people of his own nationality. In rural regions the newcomer may easily find himself the only Jew or Mexican or Italian in the community, and he may suffer both physically and mentally from his loneliness. In the city he may become a member of a Mexican or Jewish or Italian community, in which he finds partially reproduced the speech and food and traditional customs of his former home, so that the shock of his introduction to a strange world is mercifully lessened.

In the same way cities give opportunity for collections of people of like minds who might be completely isolated in smaller communities. Sculptors, painters, poets and members of the smaller political and religious sects find others of their own kind. Frequently these minority groups are composed of sensitive persons; coming together, the shock of exposure to a critical community is lessened, and greater effort is stimulated by the intelligent appreciation of the group. There is real value in this feeling at home, physiological as well as more intangible.

X

In theory, given sufficient effort and money, it is possible to cancel all the city's deficiencies as a place to live; but we may do well not to expect a rapid change. The application of all our fine knowledge calls for a combination of group unity and expenditure of money on a scale that men have seldom reached. In war time, when victory is desired so fervently that considerations of cost and immediate convenience are overruled,



CLIMATOGRAPHS SHOWING HOW DIFFERENT CITIES ARE DISTRIBUTED WITH REFERENCE TO CLIMATE AS MEASURED BY RELATIVE HUMIDITY AND WET BULB TEMPERATURE. THE SHADED CLIMATOGRAPH SHOWS THE MOIST HABITABLE CLIMATE FOR THE WHITE RACE, BASED ON CLIMATIC CONDITIONS IN THE TWELVE LARGEST CITIES OF THAT RACE, INCLUDING LONDON, PARIS, BERLIN, NEW YORK AND CHICAGO. (MAINLY AFTER GRIFFITH TAYLOR.) NUMBERS 1 TO 12 REFER TO MONTHS OF THE YEAR AND THEIR LOCATION ON THE CHART GIVES THE AVERAGE WET BULB TEMPERATURE AND THE AVERAGE HUMIDITY FOR THE PARTICULAR MONTH. THE CLIMATOGRAPH FOR CHICAGO IS PRACTICALLY THE SAME AS FOR NEW YORK.

large communities or even groups of nations will pour man power and physical resources into a great cooperative effort; but such outbursts of unified action are usually followed by a reaction toward individualism and economy. It does not seem likely that in our time or that of our children we shall see any such general effort to overcome the fundamental handicaps of city living. The cities will muddle along, attacking their problems here and there at their most obvious points, as an epidemic rises to point the moral, or some private organization of public-spirited people brings sufficiently continued pressure to bear on a sore spot.

There is a growing feeling, which the present economic difficulties have accelerated, that the best way to solve the city's difficulties is to leave them behind; to move to the suburbs or the country or the small town, where the surroundings are more wholesome and more manageable.

For the great numbers who will remain in the city it is very well that they hold steadily in mind the simple essentials to life that we have just been reviewing: clean air, water and food, full sunlight, warmth, moisture and quiet, and the avoidance of contagious disease; and set an individual and community course toward securing them. If their importance is fully realized there may come a time when a man will not have to give seven years of his life for the privilege of earning a city salary.

UNDER HIS OWN VINE AND FIG TREE

By RALPH E. DANFORTH
WEST BOYLSTON, MASSACHUSETTS

TREES and other plants are almost as much a part of man's natural environment as are sunshine and air and water. He can live longer without food than without air and water, but without sunshine and plants there would be no food. One's *own* vine and fig tree symbolizes two things, the normal environment and an independent supply of necessities. One hundred and twenty years ago relatively more civilized people produced food and clothing on their own land. Mary Lyon, a pioneer in higher education for women and founder of Mt. Holyoke College, with her own hands produced food on a stony hillside farm in northwestern Massachusetts, carded raw wool raised in her native village, spun the wool into thread, wove this into cloth and made her own clothes and bedclothes. Our poet, Whittier, on his native farm in northeastern Massachusetts, produced most of his own food, and in autumn drove his wagon loaded with farm produce, which he exchanged at tidewater on the Merrimack for his winter supply of salt fish brought there on ships from Maine. In my own youth I visited mountain regions in North Carolina, wherein families produced all that they consumed, trading a few items, as wool for sorghum or wheat for beef, with their neighbors, and never happier or healthier people have I seen. They lived under their own vine and fig tree, the fig being replaced by the apple and peach. Of wild grapes they made jelly by the gallon for use the year around, and many apples and peaches were dried in sunshine for constant supply. The homespun clothing was coarse, but it wore well. Woodchuck skins provided shoestrings for shoes, some of which were bought in town.

"But we can not live that way now," say we, "we have forgotten how, and would not want to work so hard if we could."

We pride ourselves that agricultural machinery permits fewer farmers to produce more food, and we leave it to them while we work in office and factory, receiving salary or wage, working for others, yet feeling superior to those dwelling under their own vine and fig tree. We perform marvelous feats to get the exercise and the sunshine we feel we need. Suddenly our industrial organization finds itself overstocked with the numerous wares we help make or distribute, and many wages and salaries are cut down or cut off. However cheap food may then be, it can not be bought without money, and one does not feel very noble receiving either money or food as a gift. Perhaps a small percentage of such folk have imagination enough to think of the vine and fig tree and wonder what has happened to them. For a change they do not feel so superior to those who dwell under their own sources of supply, but console themselves with the thought that there are many in the same state as themselves, and with the added thought that the times will soon improve. "Improvement is just around the corner," people keep saying, but lower and lower drop the wages and fewer grow the names on the payroll. Where is our ability to produce our own fundamental necessities, ability which Mary Lyon and Whittier and a host of our own ancestors had one hundred and

twenty years ago and for ages unnumbered before then?

It is a matter of record that some nine and one half centuries B. C. "Judah and Israel dwelt safely, every man under his vine and under his fig tree, from Dan even to Beersheba, all the days of Solomon." Those days were long looked back to with envy, even though they were days of hard work and much additional forced labor to support the government and carry out its program of construction, all of which was added to the care of individual farms and gardens.

Hard work, drought, pests, crop failures often recurred to disillusion the man with rosy hopes, but the ideal of dwelling under his own source of supplies would not down. More than two hundred years after Solomon's time a prophet arose among his people who, in describing good things for the future, included "they shall sit every man under his vine and under his fig tree; and none shall make them afraid: for the mouth of the Lord of hosts hath spoken it." And two hundred years after this prophet another prophet arose who still painted the the ideal future: "In that day, saith the Lord of hosts, ye shall call every man his neighbor under the vine and under the fig tree." And now, some twenty-nine centuries after Solomon's time, many city-worn men and women feel an urge to the land again; they want to be close to supplies, to live out in the sunshine, to be sheltered by their own living trees, to sow and gather their own herbs and roots, to drink milk of their own cows and water of their own springs and burn wood of their own forest and hear the cackle of their own hens, even though they do not aspire to spin and weave their own clothes as did Mary Lyon and countless others.

But in the northern states climate is hard. The growing season is short. Winter is long and trying to man and to his live stock. Much food must be stored for man and beast. Barns and storage cost much labor and money. Machinery and modern methods lighten the load even of the northern farmer, making his burden less than that of those who farmed the same lands in earlier generations. More southern latitudes offer more generous rewards in longer growing seasons, larger returns, more sunshine and less storage for winter. Greater variety also can be produced on one spot in milder climates. Less fuel is required. Smaller and less substantial barns are needed. Finally, in a subtropical climate, or in the highlands of the tropics, one may literally spend much of the time under his vine and fig tree.

Should the northerner contemplate living in the tropics there will be some who will try to make him afraid. If they tell him that in the tropics it takes work to produce food, they will tell the truth. One of the many absurd myths current about tropics is that there one needs only to reach up and pick his food off a tree at any time. But equally fallacious is the myth that white men can not keep well and efficient in the tropics. Equally untrue is the general notion that tropics consists of either stretches of burning sand, with here and there a clump of palm trees, or else it must be a steaming and impenetrable jungle. There is also the wide-spread notion that even if tropical disease is prevented there still remains something indefinable about the tropics which render it unsuited to civilized man.

It is not my purpose to urge all those who wish productive independence to try the tropics. I simply want to state here that I have personally lived and labored healthfully some years in the tropics and am acquainted with many more who have done so, even at sea-level, although highlands of several

thousand feet above sea offer better temperatures and often better conditions in other ways. The abundant sunshine for man and his crops, and the absolutely all-the-year outdoor climate are the big appeals of the tropics to any who appreciate these two items. It is my own fond hope to again seek the tropics and there work under my own vine and fig tree.

There are limited localities in the tropics where excessive heat, running far above 100 degrees F., are frequent, but I have had no experience with such localities and do not want such. In the more moderate tropics which generally prevail I have spent much time trying to ascertain the cause of the wide-spread belief that white man degenerates in the tropics. I found cases where there was a falling off in efficiency, but more cases where there was little or no falling off, even after many years of unbroken residence, and many cases where there was actual increase of strength and efficiency. In every case where there was diminished efficiency it could be traced to one of three causes: (1) Neglect of well-known precautions against tropical diseases; (2) deliberate departure from moral or temperate life; (3) lack of systematic exercise. This latter is perhaps the least understood of the three causes, for, contrary to the opinion of many, it is just as important to exercise and to exercise hard and systematically in the tropics as in the North. This I found to be the secret of the increase in vigor which some experienced, together with the abounding fresh air at all times and daily sunshine. By avoiding the tropical diseases, which are no worse than many northern diseases, and by avoiding vice and drink, and by taking plenty of exercise every day, in athletic sports, swimming, climbing or in real labor, any one ought to be able to keep in prime condition in any of the ordinary tropical localities. He would do well to avoid places where temperatures above 100 degrees prevail, or where excessive humidity is the rule. Best of all, let him seek the choicest spots in the highlands. The day will come when the United States will see the wisdom of Great Britain and France in providing themselves with ample realms in the tropics. But it is too late to do this now, and the general public will be blissfully unaware of the lack for some time to come.

Meanwhile, a most wholesome appreciation of the value of outdoor life, of gardens, of sunshine, of birds and flowers and trees is growing up in our midst. A wide variety of vitamin-containing foods come to us all from far and near, fresh as if just picked, and inexpensive at all times of the year. We are fortunate far above our ancestors in many respects. National parks, wild life preserves, bird and flower sanctuaries, open spaces, parks and beauty spots are being set aside and are being appreciated and used increasingly. Boy scouts and girl scouts are entering into a new fellowship with trees and flowers, birds and woodcraft. But this is but a return to the old, time-honored normal way. Through prehistoric ages of unknown antiquity man has lived close to trees, birds, plants and beasts. Earth herself has nourished him, in response to very strenuous efforts on his part, and sunshine, shower and air have conspired to render him tough and sturdy.

Under our rapid industrialization we have, many of us, departed from the normal, shut ourselves behind our new glass windows, excluded the ozone and much of the sunshine, turned our backs on trees and soil and vine and fig tree, and congratulated ourselves that we get money instead of potatoes or grain or apples for our pay, and that with this money we may buy all and whatever we please. Ah yes, quite so! But there seems to come a hitch, even in this well-

oiled system. Somehow industry has its times of drought, its pests, its years of failure. And in times of utmost prosperity its reaction on our physique, and sometimes on our moral life, is not quite all that one could wish.

An eminent professor of law in Duke University has proposed an agricultural army, with semi-military discipline, in which whole families of the unemployed might be kept together and trained to earn their own living from the soil. Large encampments of such people, individuals and families, would be located on large tracts of land in different parts of the United States, and under direction of government experts taught and compelled to produce their necessities. He suggests this as not only better than the dole, but a real cure for unemployment. Too many are ready to say, "we never can go back to producing all we need from the soil." Why not? Under one's own vine and fig tree many a life will be spent happily while life endures on this earth.

For a century there has been a tendency to move certain agricultural activities out of such regions as New England into other parts where greater returns for efforts expended might be had. Some such tendency is noted in other industries also. Summer homes are replacing thousands of New England farms, not only on the seashore but throughout the length and breadth of the region. Old pastures are being replanted with pines. Should this tendency increase sufficiently, the region would be one of summer homes, timber production and of sufficient gardens and dairies to supply the summer folk.

If this same tendency should increase yet more, highlands in the tropics would be utilized for agriculture, manufacture and industry in general, while bleaker, winter-smitten regions become increasingly used for summer resorts and forestry. Should aviation become as safe, cheap and common as some predict, travel from tropics to the north and travel around the world would be a commonplace.

Under extended communication the rigors of long winter would be borne only by those seeking winter sports, while every day would be a growing day for the scientific agriculturist and horticulturist, and the manufacturer would forget that he had ever been required to heat a factory or to make it tight and warm against inclement weather. His factory "hands" could have each his own vines and fig and other fruit trees and be happy in the care of them the year around, besides enjoying outdoor air always freely circulating throughout the factory. Should business stagnation again occur, the employees would have spacious orchards, fields and gardens to fall back upon in time of dearth, fields and orchards which could produce something in every season. Doles would not be needed to keep starvation from any door. Perhaps the old prophets were right about every man being happy in the future under his own vine and fig tree.

Too many of our office jobs, shop jobs and diverse employments fail to develop the physical man or woman to full strength and vigor. Our race is in danger of degenerating, as was shown clearly by the physical tests given in selecting those who were to serve in the last war. Nothing can wholly replace systematic, daily, outdoor work.

Fresh air, sunshine and general exercise of the whole body seem to be a daily requirement for every healthy person, a *sine qua non* of real, abiding, heritable health. Some people with a great birthright of abounding health can seem to do without it, year after year, yet I believe they are consuming their birthright, and will have less to stand by

them in old age, and certainly less to transmit to their offspring of this abounding health and vigor. Some people can long endure the drain of habit-forming drugs, drink and sex excesses, but the health which they possess is theirs by inheritance, in spite of, not because of the punishment their bodies are undergoing.

Whether born with much health or with little health the expenditure of one's energies in constructive ways, daily, systematically, as much in the open air and sunshine as may be wise, will tend to conserve or even increase the health and vigor we inherited.

The secret of improving the human race lies in passing on to our offspring—not so much better laws, better government, better institutions, more money—as better health, more vigor, brighter minds, larger, deeper, purer souls. This can best be done by the individual himself, rather than by others for society in general. The individual himself or herself can conserve, develop the most desirable traits to transmit to offspring and so combine these with traits in a carefully chosen mate, as to pass on a richer and better inheritance than either mate received alone.

It is said that at the Third International Congress of Eugenics it was shown that American families are sending twice as many children to institutions for feeble-mindedness as to universities. Negative eugenics and legislation may be able to help reverse these figures, and thereby a great good would be done to society in general; and yet the general health and mental and moral status of the better members of society might not be improving in the least, in fact, might be diminishing under indoor life and unnatural practises. The hope for a better race in future lies with the best individuals personally choosing to live normal, health-building lives, free from all vicious follies, full of constructive virtues, and mating only with those who have more to add to their hereditary values instead of mating with those who may dilute the rich blood stream.

To the all-essential hereditary values passed on to the offspring, should be added environmental values in the form of beautiful surroundings, congenial companions of the highest integrity and ability, health-giving activities, joys and recreation, work and always creative, constructive employment. The creative instinct is strong within the best of people and in some also who are far below the best. This creative instinct may manifest itself in sex activity, either creating offspring or, more often, in wasted although perhaps lawful "expression." One of the most wide-spread errors or mistakes of mankind lies in thinking that any health, beauty or value lies in such waste. Many are even told that manly strength is increased by such activity, or that it is necessary for health or happiness. Neither man nor woman needs any such activity. When expressed in the production of offspring of really superior quality it is one of the finest achievements of mankind. When gratifying a mere desire, or even a companionly impulse, it might far better be supplanted by something more truly constructive and more intrinsically valuable. The poisoned or polluted mind is easily fooled into thinking that the ways of disintegration are good. In all the world of nature, vegetable as well as animal, nothing but dire disease consumes more energy than sex. Many a creature lives, grows, reproduces and therein expends its every ounce of energy and life. Even the longer-lived animals and plants have their times of reproduction sharply restricted, with long intervals of preparation and storing of energy for the important event.

The way in which man has departed from nature and her laws, and thinks himself above law and an exception to the laws of all animate nature, which he considers beneath him and a thing apart from himself, is one of the most crying mistakes to which human judgment is prone.

Fruit trees store up energy in the cells below the bark, gradually preparing for the great ordeal of producing a crop. The wheat plants in the field expend all they have in producing man's staff of life. They die in the act, as do myriads of other creatures. The wild birds go through a long time preparing for their periods of parenthood. Man, on the contrary, cares little how he throws the torch of sacred life. He is superior, he thinks, to all nature, why be governed by its laws. Is not the impelling urge within him sufficient proof that it is wise and right to follow it blindly? Why is not life enriched and beautified by the more self-expression? Expression in what, for what, and to what purpose, may we ask?

The vine and the fig tree have lessons to teach the men who live happily and toil beneath them.

It seems almost a pity that those who would like to choose their own heredity can not do it. Several things can be done, some of which favor the offspring, while others improve only the person doing them. One may choose about half of the heredity of one's offspring. One may avoid great waste of energy through anger, sex and fear. One may steer clear of racial poisons and of many diseases which not only greatly damage self but lower the vitality of the offspring. One may choose, among the many hereditary traits one has received, which ones shall be developed and stimulated and which shall be suppressed or inhibited. One may surround himself with an environment most favorable for self and for offspring, including associates of the highest order, nutritious food consumed sparingly, comforts of home, ideal location, gardens and trees and scenery. One may fill the mind with beautiful, pure, noble, useful thoughts only and always. These environmental and disciplinary factors will continually improve one's entire personality, including looks, health and happiness. One may fill the heart with a living faith of the kind which works ever for progress.

If horticulture be not one's vocation, it may make a most salubrious avocation. The plant world is nature's primal setting for man and the entire animal world. Nothing could be more wholesome than living and working with forest, orchard and garden. There are fruits to fit every palate and every need. Most of the choice fruits are as yet unknown outside of restricted localities. Some may question this last statement, since most of splendid fruits of the temperate zone are pretty well known in the temperate parts of the globe, and many tropical fruits are known and grown around the tropical belt. Yet there are literally hundreds of choice tropical fruits which have not yet been widely dispersed. And many less choice fruits are capable of great improvement in the future under the care of the horticulturist and plant breeder. A mere list of names of the tropical fruits already desirable would astound the average person, even in the tropics.

Our first and most versatile president pronounced agriculture the most delightful and useful occupation. He was horticulturist, animal breeder, agronomist, importer of new plants, trees and animals, and an experimenter of the highest order in his day, a real pioneer in agri-

cultural research. He used his vast estates and wealth to operate the first extensive agricultural experiment station in America. He kept ever in touch with his contemporary pioneer, Arthur Young, of England and France, who did the same for experimental agriculture and horticulture in the Old World. When George Washington was not running the U. S. army or the U. S. presidency or building up the U. S. constitution, he was running the U. S. agricultural experiment station as his own private vocation.

What better than to spend a part of one's leisure with the fruit trees? Progress is likely to increase leisure. Increased leisure will be more rope for fools to hang themselves with, or a stronger, higher ladder for the wise to climb with.

The home with its garden and orchard may well be an Eden the year around. It need not be excessively hot or cold; it need not be spoiled by much noise, gas or dust of traffic; it may produce much of life's necessities; it may ever be molded by its owner into more perfect beauty and content; it may ever be improved and, in so doing, improve its habitants. Its trees reach up toward the heavens whither its owner's spirit often soars. Its flowers and fruits feed both body and mind. The living things are companions to the living people. Birds and insects coming to the trees add their sprightliness to the whole association. Heaven's sunshine brings the orchard power from far beyond this earth's domain, feeding the owners with more than a trace of the sublime. Starlight falls on the leaves and boughs by night, with its delicate and perfect touch adding charm and grace ineffable. The trees with the song and the chirp and the gleam of the life and the light around them constitute the perfect surrounding for the happy man who is neighbor to all men, under his vine and his fig tree.

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THE NEW KIND OF MATTER: ELEMENT ZERO OR NEUTON

By Dr. W. D. HARKINS

PROFESSOR OF CHEMISTRY, UNIVERSITY OF CHICAGO

THE year 1932, which has just closed, will always be memorable in the history of human progress as that in which Neuton, the most remarkable of all the known kinds of matter, was discovered. Like all the earlier fundamental types of matter called elements, neuton is made up of atoms, but these possess a remarkable, previously unknown characteristic—that is, while they are like all other atoms in being electrically neutral, they are excessively small. Thus they are so minute that more than a million-million of these new atoms, or neutrons, could be contained in the volume of any ordinary atom and still leave some space which is not occupied. Since a neutron has about the mass of an ordinary atom this means that its density is excessively high. Thus if a lady's thimble could be filled with the neutrons in contact, the material in it would have a weight greater than that of all the warships of all the navies of the earth.

However, this new material could neither be held in a thimble nor in a heavy tightly sealed metal box, since it passes easily through any known material. That is, these neutrons are so minute that they pass very readily through other atoms without producing any disturbance or indeed any noticeable effects.

Other particles of somewhat the same size and weight as neutrons have been known for two decades, but they have always been charged with positive electricity. Any such positive particle serves as a nucleus, around which there gathers very quickly a diffuse cloud or aura of negative electricity. The nucleus, together with the surrounding negative cloud, constitute what is commonly known as an atom, the whole of which has a volume a million-million times as great as that of the nucleus alone. It is usually considered that this diffuse cloud which collects around the positive nucleus of an atom is made up of negative electrons. The number of these is determined by the charge on the nucleus. Thus the lightest ordinary atom is that of hydrogen, the electronic cloud of which consists of only one negative electron, which is held by one equal positive charge on the proton which serves as the nucleus of this atom. The number which gives the value of the total positive charge on any nucleus, and also the number of electrons in the surrounding cloud, is called the atomic number, and this is 2 for helium, 7 for nitrogen, 8 for oxygen, 26 for iron and 79 for gold.

All these elements have chemical and physical properties which are more or less repeated by other elements. Thus sulphur (16) is somewhat like oxygen (8), and silicon (12) is somewhat like carbon (12).

Not so, however, with element zero, which is totally different from all the other elements, just as the number zero is different from any positive whole number. Since the nuclei of the atoms of this element carry a zero electrical

charge they are neutral, which suggested that the atoms be called neutrons.

The neutron, unlike other nuclei, attracts to it no cloud of negative electrons. This remarkable characteristic is an obvious result of its electrical neutrality. The minute size of this atom is, then, due to the fact that it always exists as a nucleus alone without any surrounding electronic cloud.

Neutrons were discovered early in 1932 in the rays sent off by the light element beryllium (atomic number 4) when a small piece of this material was bombarded by helium atoms flying at about nine thousand miles per second. The experiments were carried out by Irene Curie Joliot, the daughter of Madame Curie, and her husband, M. Joliot, but the fact that the rays contain neutrons was first recognized by Chadwick of Cambridge, England.

That the nucleus of an atom of beryllium contains a neutron was indicated in 1915 by a curious arithmetical discrepancy. According to the hydrogen-helium theory of atom building, developed at that time by the speaker, the atomic weight of any light element of even number should be twice its atomic number, and this is in general true. The single exception was beryllium, which, since its atomic number is 4, should have the atomic weight 8, while the actual weight is 9. To explain the discrepancy it was assumed that the beryllium nucleus contains not only two helium nuclei, each of mass 4, but also a neutron, or electrically neutral particle of (very nearly) the mass of a hydrogen atom, which seemed probably to consist of a closely united proton and electron, while a hydrogen atom consists of these same two particles relatively very far apart.

Not only was the existence of the neutron predicted but also its mass and properties were given in 1920 by Harkins (April 12) and by Rutherford (June 3), both of whom assumed the neutron to be one of the fundamental particles concerned in the building of other atoms.

It is apparent, from the description already given, that the neutron is the only atom which possesses the unique characteristic of being at the same time an atomic nucleus and a complete atom. Since it is a nucleus it is best studied by the methods used to investigate other nuclei, and these are extremely simple.

When a beryllium atom is struck by a helium atom moving at a rate of about nine thousand miles a second, a neutron may be emitted at about 20,000 miles per second. This neutron may pass for thousands of feet through air without producing any apparent effect, but if by chance it strikes the nucleus or center of an atom in the air very remarkable effects may be obtained, and these may be revealed by photography.

Atoms which move through air at the rate of ten thousand miles a second may be made to produce tracks, which appear as brilliant white lines, by means of an apparatus devised by C. T. R. Wilson. An electron produces a dotted, crooked line; a hydrogen atom, a fine straight line; and any other atom a heavy straight or slightly curved line. Neutrons are the only atoms which produce no tracks at all.

If a fast helium atom hits the nucleus or center of a nitrogen atom, the single track of the helium atom changes into two tracks, one very fine, which shows that hydrogen has been produced, and one shorter and much more coarse, which shows, from the lengths of the tracks, the angles and the atoms involved, that an atom of oxygen has been formed. Thus helium and nitrogen are converted into hydrogen and oxygen, which involves both a disintegration and a synthesis of an atom, and one of the dreams of the alchemists is realized. In this process energy is converted into mass.

The neutron produces no track in the

apparatus, but when moving at the rate of about twenty thousand miles a second it may collide with the nucleus or center of a nitrogen atom. In this case Dr. Feather has shown that the neutron adds itself to the nucleus, which splits in two; into an atom of helium and one of boron, while Harkins, Gans and Newson have also secured photographs of such disintegrations and find that the nuclei seem to exhibit different definite energy levels or quantum states.

Whenever a neutron adds itself to another atom mass is lost and converted into energy, and this gives a high velocity to the fragments of any atom which may be disintegrated.

A simpler case to discuss is the addition of hydrogen to a heavier atom. It will be seen that heavy atoms, like my listeners, do not like decimal fractions. The weight of a hydrogen atom is 1.0078, while the weight of a heavier atom is in general a whole number. Thus, if a hydrogen atom is added to a heavier atom, such a fluorine of weight 19, a neon atom of weight 20 is produced, and the mass 0.0078 is converted into energy. Thus the decimal part of the mass of a hydrogen atom loses the form of ordinary mass. This small amount of mass represents a large amount of energy equivalent to the action of seven million volts on an electron. This energy causes the neon atom to be unstable, since it can not hold this excess of energy, so it splits apart into two parts, presumably into an atom of helium and one of oxygen. Such experiments were carried out in 1932 by Cockcroft and Walton.

The amount of energy which should be liberated in such a transformation of hydrogen was calculated in 1915 by Harkins and Wilson by the use of Einstein's relativity equation, which indicates that one gram of mass is equal to a number of energy units (ergs) equal to the square of the velocity of light in centimeters per second. Harkins and Wilson showed that the amount of energy given by the conversion of one pound of hydrogen into a heavier atom gives in general as much energy as the burning of ten thousand tons of coal.

Since hydrogen can be bought at a cent a pound, coal at five dollars a ton costs five million times more for the energy produced than hydrogen. The difficulty in the use of this atomic transformation of hydrogen as a source of power lies in the small size of atomic nuclei. Thus both the nucleus of the hydrogen atom, which acts as a bullet, and the heavier nucleus, which must be hit, are so small that a great many hydrogen nuclei must be fired from an electrical gun at high speed, in order to obtain a single nuclear collision, or hit. All the hydrogen nuclei which do not hit are wasted.

The experiments of Cockcroft and Walton show that the magnitude of the energy actually produced is just that calculated by Harkins and Wilson, equivalent to 7 million electron volts. This thus serves as a confirmation of Einstein's equation developed from his special theory of relativity.

Thus it is found that atoms, such as neutrons and hydrogen atoms, which have a decimal fraction in their atomic weights (hydrogen 1.0078, and the neutron 1.0067), lose this decimal part of the weight when they unite with a heavier atom, and the large amount of energy thus liberated disintegrates the atom which is temporarily formed. Usually the atom splits into helium and whatever else is left.

However, the decimal mass of a helium atom is relatively small and amounts to less than 2 million electron volts, so fast helium nuclei often add themselves to other nuclei on collision and thus build up heavier atoms, since the atom which is formed is either able to hold this smaller excess of energy, or else it is liberated as radiation.

Just how important a particle is rep-

resented by the neutron is not entirely known, since it was discovered only a few months ago. However, the most fundamental particles now known are the electron (negative), the proton (positive), and the neutron (neutral). The neutron may be (1) a proton and an electron united with an energy of about a million electron volts, or (2) a more fundamental neutral particle, which, when combined with a positive electron, becomes a proton. At present the known facts seem to be somewhat more in accord with the idea that it consists of a proton and an electron, that is, that its composition is the same as that of a hydrogen atom, though its volume is excessively less.

The possible great significance of the neutron is emphasized by the rapidly growing idea that all atomic nuclei consist merely of neutrons and protons. This possibility was indicated about ten years ago in connection with a formula developed both by Masson and by the speaker. The idea that this formula represents the constitution of all atomic nuclei has been developed into a theory by Heisenberg, a prominent theoretical physicist.

The most important relations which are apparent are: (1) In general one proton, but not more than one, unites with a single neutron; (2) almost all the neutrons in atomic nuclei exist in the form of pairs; (3) almost all light nuclei are built up from helium nuclei, which may be formed from neutrons and protons.

While before the discovery of the neutron there were facts which seemed to a few to indicate that such a particle should exist, the discovery of its existence and of the fact that it adds itself to other nuclei will have, in the next few years, a remarkable influence not only upon the science of the constitution of matter but also upon that related philosophy which has become so influential during the last half decade.

PLANTS THAT FORM REEFS AND ISLANDS

By Dr. MARSHALL A. HOWE

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SINCE the days of Charles Darwin, the corals have enjoyed a world-wide fame as reef-builders or island-formers. Poets have acclaimed the wonderful achievements of the "lowly coral insect." Scientists, while unwilling to admit that corals are "insects," are unanimous in accepting them as members of the animal kingdom and in crediting them with very important activities in the way of building up islands or atolls, where once only salt water was visible.

To-day, however, we are concerned with plants that are active and important in the same way. Some of these plants have a superficial resemblance to the corals, and the earlier naturalists did not always distinguish the two groups clearly. These plants, which are members of the large group known to botanists as the algae, secrete or precipitate lime from the surrounding water and sometimes become as hard and as stone-like as the corals themselves. The fact that plants, at least at times and in places, are fully as important as the corals in reef-building and land-forming has received no particular emphasis until rather recent years. The beginning of this belief may be traced to the publication, in 1904, of the report of the Coral Reef Committee of the Royal Society of London. This report dealt particularly with the island of Funafuti, of the Ellice Islands group in the

"South Seas." Funafuti was selected for intensive study by this committee because it was believed to be a "typical coral island" or atoll. Borings were made at various points, one of these to a depth of more than 1,100 feet. The cores brought up by the drill were analyzed and the different organisms contributing to the upbuilding of the island were listed in order of their relative importance. The first rank was given to *Lithothamnium*, meaning certain lime-secreting plants belonging to the group known as the red algae. The second rank was assigned to *Halimeda*, meaning certain lime-secreting plants of the green algae class. Third rank was given to the Foraminifera, a group of microscopic organisms belonging to the animal kingdom. The fourth rank went to the corals. So Funafuti is apparently "a true coral island," in the upbuilding of which the corals have played a minor part. The fact that the investigators, in this case, were for the most part zoologists, should relieve botanists of any possible suspicion of trying to filch the coral reefs and islands away from the zoologists! There should doubtless be a new name for "coral reefs" that are not coral reefs, but words and ideas that are once imbedded in the mental processes of *Homo sapiens* are difficult to dislodge. "Algal reef" and "algal island" lack the poetry, tradition and euphony of the well-established names, even though the latter may be misnomers. That Funafuti is not an isolated instance of the dominance of the plants in this field is indicated by the observations of Finckh at Onoatoa, of Mayor at Rose Atoll, of Setchell at Tahiti and Tutuila, of Pollock at Oahu and J. Stanley Gardiner at the Chagos.

Finckh has stated that a certain "nullipore" (an old name for one of the coralline algae) "is actually the reef-former at Onoatoa" in the Gilbert Islands. Mayor, writing of Rose Atoll, in American Samoa, says: "The whole visible rock of the atoll consists so largely of Lithothamnium that we may call it a 'Lithothamnium atoll' rather than a 'coral atoll.'"

Setchell, after a visit to Tahiti, in the South Pacific, states that "The conspicuous reef-former, both on the barrier reefs and on the exposed fringing reefs, is *Porolithon onkodes*." This organism with a rather long Greek name is a hard rock-like plant.

J. Stanley Gardiner, distinguished British zoologist, after an expedition to the Chagos Islands in the Indian Ocean wrote: "The reefs of the Chagos are in no way peculiar save in their extraordinary paucity of animal life. . . . However, this barrenness is amply compensated for by the enormous quantity of nullipores (Lithothamnia, etc.) encrusting, massive, mammillated, columnar, and branching. The outgrowing seaward edges of the reefs are practically formed by their growths, and it is not too much to say that, were it not for the abundance and large masses of these organisms, there would be no atolls with surface reefs in the Chagos."

Pollock, in a rather recent paper on the fringing and fossil reefs of Oahu, the best-known of the Hawaiian Islands, states that "the organisms chiefly contributing calcium carbonate to both fossil and fringing reefs are corals and coralline algae. The algae contribute more than the corals."

Bermuda was commonly considered a coral island, until the studies of Alexander Agassiz and Henry B. Bigelow indicated that corals have played a rather minor part in its formation.

Your speaker was once becalmed, or nearly so, for two days out of sight of land in a small sailboat on the Bahama Banks, where, for many miles, the water is only from ten to one hundred feet deep. Except when agitated, the water on these banks is of crystalline clearness, and when a calm leaves the surface

as smooth as a mirror, it is very easy for an observer in a boat to get a rather accurate idea of the nature of the plants and animals growing on the compacted sand and rubble at the bottom. One may then note that the corals are rare on the Bahama Banks and that the lime-secreting algae are very abundant.

There are, however, doubtless such things in the world as coral reefs, the upbuilding of which has been due chiefly to corals; a notable example of such seems to be the famous Great Barrier Reef on the northeast coast of Australia. But there is increasing evidence that the atolls, reefs and low islands of the Central Pacific, long considered the classic examples of the results of the activity of corals, are in a dominant way monuments to the long-continued growth of lime-secreting plants belonging to the marine algae.

Corals thrive in rather shallow water. Dr. T. Wayland Vaughan has stated that 25 fathoms is the greatest depth at which reef-building corals work effectively. The coral-like plants flourish from low-water mark down to depths of at least 100 fathoms—a depth four times as great as that enjoyed by the corals. The corals are confined to the warmer parts of the ocean. The stony coral-like algae are found not only in the tropics but occur also in great banks off the coasts of Norway, Iceland, Greenland, Spitzbergen and Nova Zembla. In the tropical Dutch East Indies, Dr. Weber-van Bosse has described and photographed reefs of coralline algae exposed at an extremely low tide and stretching away "as far as the eye can reach."

Neither the corals nor the lime-secreting sea-plants can survive for any great length of time above the low-water mark. When the corals and coral-like plants, working together or more or less separately for centuries, have built up a mass of limestone rock close to the surface of the sea, the red mangrove tree, with wonderful adaptations for a semi-aquatic life on a young reef, such as boring, stilt-like roots, very often appears and carries on the work of forming dry land where once there was salt water. The arching, branched, widely spreading roots of this remarkable tree form an admirable trap for catching driftwood and a great variety of organic and inorganic débris. Soon there is a sort of muddy soil that will sustain other aquatic or semi-aquatic plants of the flowering or seed-bearing group and in the course of time there is formed a soil that is adapted to plants of drier land. Some of the older navigators of smaller craft along the shores of southern Florida say that low uncharted islands have appeared within their memories. Sometimes there is a gradual rise of the sea-bottom or a more abrupt upheaval that helps to transform a wave-swept reef into an island. In remote geological ages, as is well known, there have been mighty upheavals that have lifted mountain ranges of the present out of the seas of the past.

Your speaker has recently enjoyed the privilege of examining specimens of limestone from an ancient reef in the Coast Range Mountains of Santa Barbara County, California. This old limestone of Eocene age, recently investigated by geologists of Stanford University, is said to be about 225 feet thick. Although now more than 3,000 feet above the present level of the sea, this reef consists very largely of the remains of lime-secreting marine algae, with microscopic cell-structure beautifully preserved, though parts of the deposit are made up chiefly of minute lime-secreting animals of the Foraminifera group. No corals are found. There is a somewhat similar marine-algal reef now high and dry in the Santa Monica Mountains in Los Angeles County. There are others in southern Europe, northern Europe, and northern Africa.

It is of interest and importance to note that most of the coral-like sea-plants contain large quantities of magnesium carbonate as well as of calcium carbonate, while the corals are notably deficient in magnesium. It seems highly probable that the magnesian limestones, known technically as the dolomites, owe their origin to the chemical activity of plants, that is to say, of algae. The researches of Willstätter, eminent organic chemist of Germany, indicate that magnesium is an essential element in chlorophyll, the green pigment characteristic of all plants except the fungi and bacteria. The association of magnesian limestones with the chlorophyll-bearing lime-secreting plants seems perfectly natural and logical.

In addition to the rather large, easily seen lime-secreting plants of the sea, there are also in our fresh-water streams and lakes and in hot springs microscopic algae, mostly belonging to what is known as the blue-green group, that precipitate lime when growing in water that is more or less charged with a form of lime in solution. There is a considerable amount of evidence, not, perhaps, altogether incontestable, that these minute algae were the producers of the extensive deposits of lime that are found among the sedimentary rocks of the earliest geological ages. The researches of the late Dr. Charles D. Walcott in the Rocky Mountains, of Dr. David White in the Grand Canyon, and of Professor E. S. Moore in Canada are of special significance in this connection. But that is another story. For to-day we rest with a reaffirmation of our belief that in the formation of many, if not most, of the so-called coral reefs or islands, lime-secreting plants—the algae—have contributed more than have the corals.

BORDERLINES OF SANITY

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In these times of shifting values, heavy financial losses, forced struggles for vital existence and increasing competitive activity, including disconcerting noises from all kinds of machinery, the result of the so-called "machine age," the nervous and mental organization of the human being is called upon to carry an unusually heavy environmental load, a burden which at any time may strain the individual to and beyond his capacity to stand the situation in which he finds himself. The actual danger to mental health inherent in such situations, while an important factor, is perhaps no greater than the devastating fears and apprehensions engendered and enhanced in those, who under the additional stress are developing pernicious habits of self-scrutiny, which tend to overrate the significance of simple mental fatigue or to misinterpret curious or slightly abnormal mental traits as signs of an unsound heredity or of a pending disturbance of mental integrity.

Man, in common with all other living things, is an adaptable being trying to preserve his organic unity and equilibrium; and in spite of the fact that he is controlled to a large extent by primal instinctive impulses, as hunger, sleep, fear, aggressive trends and love strivings, which have to be adjusted to the laws of his complex society, he has succeeded by and large in this type of adaptation. Man is entirely a part of nature, and nature does nothing by accident or by chance, but only by means of universal principles. From the beginning of life until death the one ever-

present factor in a living being is its endless adaptation, which includes all the best expressions of the creative side of life; all in art, music, the drama, literature, the great mechanical inventions, the profound scientific hypotheses and the various systems of philosophy and religion.

Man is the outcome of a gradual evolutionary process, during the course of which the physical organs and the mental capacities and tendencies have developed together. Therefore, any division of traits into "physical" and "mental" is only a convenient artificial designation for the purposes of studying certain aspects. The person is a unit in spite of the complexity; each self is a unit in the group to which it belongs, and the welfare of each individual is most intimately bound up with this group. Therefore, human society is one of the most, if not the most, important features of our natural environment, and the mental state and capacities play the major rôle in the adjustment to these groups and societal situations.

The basic qualities of mind are apparently universally the same or very similar. The mind of primitive man, or the so-called savage, works after the same fashion, just as keenly and accurately as that of an educated man, the principal difference being in the store of facts. The primitive mind is more apt to reason from false premises, as the knowledge acquired is different from that characterizing the civilized educated mind, but aside from the content, the psychological mechanisms are practically identical in their behavior, a similarity which naturally holds good, with a few exceptions, into the realms of mental disorder.

Until comparatively recent times in terms of history, the idea that mental disorder was a state entirely different from mental health was universal among physicians, as well as among people in general. But it has been gradually discovered that the so-called abnormal mental manifestations are quite analogous to the normal mental processes, the difference being principally a matter of degree. This is true also of the other aspects of the body; whether one be healthy or sick, the breathing, circulation, digestion and all other vital activities are controlled by the same chemical, physical and psychological laws of nature. In illness the conditions under which these laws function have become changed, thus making it possible for the same causes to produce different results. There is no very sharp dividing line between health and disease, excepting in those instances where from acute poisoning or infections conditions have changed abruptly. Where the changes in conditions are sudden, the contrast is recognized by every one.

In mental conditions the change from health to disorder may be so gradual that at times even the experienced physician is unable to tell with certainty the extent of the trouble. Often there are intermediary stages in the transition, for which there is no gage to distinguish the healthy from the sick. There are no two individuals who are completely in accord as far as their constitutions, intellect and emotional equipment are concerned, so what is called "normal" can be little more than a notion which changes from time to time to suit the concept of averages. As far as the mind is concerned, there are many intermediary grades or borderline states which must never be judged from single individual symptoms. From simple or curious eccentricities of character to states of paranoia or from excited exhilaration to pathological maniacal excitement, the intermediary steps are very numerous, and it is not a question of individual peculiarities, but a change in the entire personality. A mental trait which in one person may be entirely normal, in another may be a sign of serious disor-

der, so great is the difference in the ways people express their painful or joyous feelings or conduct themselves in their adjustments to the various situations in life. Neither a great exaggeration nor a marked suppression of feelings, opinions and beliefs is in itself abnormal, because such a degree of activity may be normal and characteristic for one person in certain settings and definitely pathological in a person with a different set of characteristics. The matter of abnormality can be decided only by a study of the particular case, taking the total life situation into consideration along with the habit patterns in an attempt to determine just how far the total psychic accomplishment has deviated from its original or from its average efficiency.

For many years the so-called "degenerative signs" were held to indicate the existence of mental abnormalities. These signs or stigmata include peculiarities in the shape of the skull, palate, ears, hair distribution, and some kinds of "birth marks." But numerous scientific studies have shown that, aside from an abnormally small skull, which means an abnormally small brain as found in some types of feeble-mindedness, these signs of degeneration are not reliable, having little, if any, bearing on the question; since they may be present in persons of perfect mental health or may be absent in those with advanced constitutional mental disorders.

In our social organization a person is supposed to allow himself to be guided in his contacts with his fellow beings by the accepted reasonable motives, and at the same time be capable of safeguarding his own interests. We assume that every person who has developed and been trained in the accepted ethical views and notions of our social state shall have acquired the necessary moral concepts by which to direct his own conduct. Any radical departure, in speech or action, from these laws of society, particularly if it interferes at all seriously with the supposed welfare of others, places a person at once under the suspicion of having mental disorder, antisocial or criminalistic tendencies, and should he persist in this behavior, he is eventually segregated in a hospital for mental disorders or a prison. In evaluating these situations one must recognize that just as upon the one hand not every act of a mentally abnormal individual is abnormal, so upon the other hand the capability of acting according to the recognized and accepted right and wrong principle is not always present in the normal. Morbid emotions, ideas and impulses may at any time conflict not only with the power of acting correctly, but even with the recognition and appreciation of the social and personal obligations in the situation. Such emotions and impulses originate in the unconscious part of the mind, and while it is a contradiction in terms to speak of an "unconscious" idea or feeling, it is not illogical to talk about unconscious tendencies and drives to action, which create behavior problems outside of the usual control of the individual's conscious desires. In any given situation the possible influence of these factors should be known by people in general, and they must be acted upon intelligently by physicians and jurors in particular, to determine whether a person is entirely deprived of the use of his intellect or whether he is merely incapable of adjusting his actions to the demands of circumstances.

Along the borderlines of sanity, we find states in which mental disease is only partly developed, and those in which the peculiarities and inadequacies are only paroxysmally present; and also many states of disorder which are revealed only through the writings and art productions of the individual. We frequently hear geniuses referred to as borderline types, a statement which is true only in definite individual in-

stances. There is no reason why a genius should not develop a mental disorder, or a person having a mental disease show the traits of a genius, but geniuses as such are not pathologic; they are progenerates, people endowed with superior faculties, great energy, tremendous capacity for work, a combination that can be defined only in terms of its own unique mental and temperamental processes, traits, qualities and products.

It should be recognized from the very beginning that many children are constituted differently from their companions of the same age, and may not be able to adapt themselves to the general mould, but we should not consider every child in danger of a mental disorder whose psychic demeanor differs from that of his companions, as not infrequently to the astonishment of those who have anticipated trouble, these peculiar children later become the renowned members of human society. Children with extraordinary capabilities may be just the ones who rebel against restraints and systems of education and training, modeled according to some established plan, while model children are sometimes the ones with an intelligence adapted to and not exceeding the demands, or with dwarfed talent, or suffering from a lack of opportunity for development of their capacities. Some persons seem to be congenitally possessed of an individually defined life thirst of such intensity that it can not be quenched by any ordinary way of living: a situation which drives the individual into various types of pathological behavior. Interrupted ambitions, lost hopes and thwarted love lives give rise to pathological expressions of the personality, with flights into alcoholism and drug habits which are more than apt to become borderline mental disorders.

Every event in life has both an external and an internal cause. Every question of this nature has two sides. We can always consider it from these two points of view, but until we can control all the conditions of life from love, conception, birth and infancy to old age and death, and also the conditions that underlie the civilized societies, there will remain a wide field of problems that we can solve only by watching, recording and comparing the great age-long and world-wide experiments nature has always made and will continue to make. If the public is to be instructed at all in matters of mental health, and it certainly should be, the information must be more complete than it has been in the past, and must be freed from the destructive influences of fear, which is always bred in misunderstanding. For the present there is a good slogan to keep in mind concerning mental states: "It is not so much what a person says and does, but it is the manner in which he says and does it."

SCIENCE IN CHICAGO

By AUSTIN H. CLARK and LEILA G. FORBES
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"THE time is not far distant when culture, civilization's chief adornment, will give an added lustre to Chicago's fair fame; and the height of her buildings, the size of her grain elevators, and the reports of her slaughter houses will be of secondary importance as compared with the scientists, artists, scholars and musicians she has fostered." So wrote Joseph and Caroline Kirkland in 1894. As far as science is concerned, that time has now arrived; Chicago has become a most important center for all types of scientific work, and for many types the most important center in America.

As the main front door to the vast, rich, unsettled regions to the west, the land of opportunity and hope, Chicago in the early days was naturally almost entirely concerned with things material and practical. It was a typical frontier city, living close to the fundamental necessities of life with little thought of anything beyond making the most of its commercial opportunities. Extremely active in all lines of work bearing directly and immediately upon their daily lives, the people of Chicago were in those early days in a state of cultural abeyance.

Cultural abeyance rarely is of long duration. The human mind seems to require something beyond a mere routine existence; it is not satisfied with the simple planning day by day of ways and means for securing the fundamental necessities of life, or even the material luxuries. Just as soon as an adequate provision of the necessities of life becomes assured for any considerable portion of the population, the craving for the development of the non-material side of life and the desire to explore the mysterious fields lying beyond the realms of common knowledge begin to assert themselves.

The desire for cultural advancement and for scientific research is always particularly strong in a community where over a period of years the people's attention has been more or less severely concentrated on things material. And besides this, an interruption of the cultural continuity in the history of a community enables that community upon the reestablishment of cultural life—or rather upon the resuscitation of that cultural factor which, no matter how severely it may be suppressed, can never be eradicated—to build up a cultural and a scientific structure which shall be a new and virile growth free from the limitations and traditional inhibitions that in the older communities so often operate to retard true cultural progress, or to limit a cultural advance to a relatively small portion of the population.

As was quite natural, it was the purely practical side of science, finding more or less immediate social application, that first received attention in Chicago. So up to 1850 we find only organizations having to do with medicine and with applied mechanics in its broadest sense. Science at that time was largely a structure composed of a few imperfectly appreciated facts that formed a nucleus for an elaborate nebula of guesswork, strongly colored and infiltrated with prejudice and preconceived ideas. Yet scientific curiosity was not lacking, as is evident from the existence of various small commercial museums containing collections of ob-

jects calculated to interest the public, and fitted for the presentation of more or less elaborate theatrical performances.

In 1851 Northwestern University was founded, followed in 1855 by the University of Chicago, in 1856 by the Chicago Historical Society and in 1857 by the Chicago Academy of Sciences. Science in the fifties, therefore, assumed a more truly cultural aspect, and at the same time became organized.

In the sixties, as a result of the increase and improvement in transportation facilities, Chicago came to be recognized as the best location for the headquarters of organizations of nation-wide scope, and beginning in 1863 many of these became established there. It was in 1868 that the first Chicago meeting of the American Association for the Advancement of Science was held.

The World's Columbian Exposition or "World's Fair" of 1892–93 brought to Chicago many assemblages of objects of scientific interest from all over the world, and also attracted attention to the development of applied science in this country. Naturally, therefore, it gave a great impetus to the further establishment and expansion of local scientific institutions.

Chicago was incorporated as a city in 1837 when its population was only 4,170; in that same year there were organized a medical college and an institute largely devoted to science.

The early history of medical organizations in Chicago was that of a sequence of several evanescent societies mostly coming to an abrupt end through professional and personal dissensions among the members. The Cook County Medical Society held its first meeting on October 3, 1836, and the Chicago Medical Society was inaugurated during the first quarter of 1850. These two societies were merged at a meeting held on April 5, 1852.

The Rush Medical College was incorporated on March 2, 1837. In the *Chicago American* for March 25, 1837, we read: "This act may be regarded as not the least of the favors which Chicago has received at the hands of the state. Being the first institution of its kind in Illinois, or indeed west of Cincinnati and Lexington, it must soon possess advantages of location which but few medical schools enjoy. With such a situation, if it receives the fostering care of the public, it can not fail to become an ornament and an honor to our infant city. The benefits resulting from the establishment of literary and scientific institutions in a community are very great." The college building was erected in 1844, and the first lecture in the new building was given on December 11, 1844. The Rush Medical College was affiliated with the University of Chicago in 1898, and became a part of the university in 1924.

On the night of January 3, 1837, a number of Chicago mechanics met at the Eagle Coffee House for the purpose of organizing a Mechanics' Institute. At a subsequent meeting held on January 21 a constitution was adopted, officers elected and arrangements made for starting a library and museum. Five years later a reorganization was effected, and early in 1843 it was chartered as a corporation.

The objects of the society as set forth in its constitution were "to diffuse knowledge and information throughout the mechanical classes; to found lectures on natural, mechanical and chemical philosophy and other scientific subjects; to create a library and museum for the benefit of mechanics and others; and to establish schools for the benefit of their youth, and to establish annual fairs." The only requirement for membership was good moral character.

With the incorporation of the institute the *Prairie Farmer,* then the best

agricultural monthly in the West, was made its official organ, and the mechanical department of that magazine was edited by John Gage, a prominent and active member. In the year 1844 William H. Kennicott was elected first vice-president.

In 1845 the first annual fair under the auspices of the Mechanics' Institute was held, and proved a marked success.

The program of the institute consisted of lectures on the arts and sciences delivered by the best available men in the city. They were prepared for the special benefit of the members of the institute rather than for the general public. As examples of the high quality of these lectures, it may be mentioned that in 1850 Hon. William Bross gave a course of interesting and instructive addresses on geology, and Dr. James V. Z. Blaney lectured on various occasions on chemistry as applied to the arts.

In 1850 William H. Kennicott was elected president. In this year, too, the Smithsonian Institution donated copies of its publications to the institute.

In 1845 a museum was established in the Commercial Buildings, 73 Lake Street, a few doors east of the Tremont House. An advertisement of the institution published in the local papers assured the public that in it there were to be found the "best collection of specimens in natural history in the West, including an extensive variety in geology, mineralogy, chronology and ornithology. In addition there are several groups of wax figures and a superior collection of cosmoramic views." But the special attractions, as was frequently the case in museums of that time, and even much later, consisted of concerts, lectures and explanatory descriptions of the exhibits. Nothing was brought within the walls of the museum that was not "in strict accordance with propriety, morality and religion." Admission was twenty-five cents for adults and one shilling [twelve and one half cents] for children.

On November 15, 1845, the manager of the museum petitioned the council to remove the license tax, asserting that the museum was strictly "a place of instruction" and therefore should not be compelled to pay a fee. This petition was promptly denied. On February 13, 1846, the museum again appealed for more liberal treatment. On February 26 the board voted to remove the license tax with the understanding that the managers should admit no transient entertainments to their hall. Theatrical performances were also prohibited without additional contributions to the general funds.

Not long after this another application for more liberal treatment was made in which the managers said that they "would be under the necessity of closing the museum unless theatrical performances could be given free of license." This application was referred to a special committee of the council, who reported:

> We feel that the efforts of Messrs. Fuller and Sercomb to establish a museum have not been properly appreciated by the citizens, and that they have not afforded that encouragement and patronage which the merits of the museum demand. Your committee find that the museum already embraces a very interesting collection of animals, insects, birds and minerals, together with a variety of artificial curiosities well worthy the attention of the citizens and constituting a nucleus upon which, if adequately encouraged, a museum will grow up creditable to the city and profitable to the proprietors.

An order was passed granting the museum a license for six months at the nominal fee of five dollars.

Digressing for a moment we may note that the newspapers of this period reflect the almost purely commercial attitude of the population. Yet in them we occasionally find articles bearing more or less on science, or at least written on a scientific subject, often copied from

other Eastern or Southern papers, or taken from some other source that was readily available.

Thus in the *Chicago Commercial Advertiser* for Wednesday, April 25, 1849, there is an article on the animalcular theory of cholera, at that time a very serious menace, copied from the *New Orleans Crescent,* and in the same issue there is a poem in the form of a dialogue between Brandy and Cholera in which they address each other as "dread plague" and "foul poisonous drug."

In an advertisement in the *Chicago Commercial Advertiser* for Wednesday, June 13, 1849, we find a notice that "the Chicago Museum, and Gallery of Fine Arts, will open for the season on Wednesday, June 13th, under the management of Mr. Thos. Buckley." In the issue for June 20 the advertisement of the Museum says:

> The Manager begs leave to announce that he is preparing a Drummond Light which will be nightly exhibited from an observatory that is now being erected on the top of the Museum Building. The process of generating the gass will take place every afternoon at 3 o'clock to which visitors to the Museum will be admitted free of charge.

The admission to the museum was twenty-five cents, children under twelve, half price.

The Northwestern University was chartered under the auspices of the Methodist Episcopal Church in 1851, and was first opened in 1855 in Chicago. The College and the School of Music were later removed to Evanston, Illinois, but the professional departments have remained in Chicago. This university has fifty-eight professors in the scientific department, including eleven in the dental school.

In 1855 there was established on land given by Hon. Stephen A. Douglas a small Baptist college which was officially known as the University of Chicago, but was also called Douglas University. This college had on its faculty 10 professors, including the president, and two others. Mr. J. H. McChesney was professor of chemistry, geology, mineralogy and agriculture. The college was divided into four departments—I. Academy, a preparatory school; II. College, with a classical and a scientific course; III. Agricultural; and IV. Law.

Regarding the scientific course we read in the second report of the institution:

> With all the admitted excellence of the established curriculum of studies in American Colleges, it were too much to expect that it would be adapted to all the differences of intellectual constitution, and of practical aims. While, therefore, fully realizing the paramount claims of the classical course, the Trustees at the same time have deemed it expedient to provide another, which, with some important variations from the classical, is still believed adequate to the purposes of thorough mental discipline, as well as to many of the practical callings of life.

For entry into the scientific course it was provided that students would be examined in the same studies as for the classical, with the omission of Greek altogether, and of Latin, excepting Latin grammar and reader. For the freshman class in the scientific course the prescribed courses were in algebra and geometry, Latin, Greek, English and history. In the sophomore class the students studied higher mathematics, German, rhetoric and history. The agricultural course required only two years, and the conditions of admission were "the fundamental branches of a good English education." This university was closed in 1886 because of financial difficulties.

The Chicago Academy of Sciences was founded in 1857. Subscriptions were collected amounting to about $1,500, and a room was engaged in the Old Saloon Building. But the financial crisis of that year put an end to the subscriptions, and as a result the academy languished. As the hard times wore away the enthusiasm of its promoters

revived, and in 1859 a new effort was made, the members of the academy incorporating themselves under the name of "The Chicago Academy of Sciences."

One of the more earnest and enthusiastic workers for the academy was Robert Kennicott, who had long had the idea of building up a museum of natural history in Chicago. By the time he was twenty-four years old he had traveled widely over the entire northwest, and had done considerable work in systematic biology. In 1859 under the direction of the Smithsonian Institution he led an exploring expedition into British and Russian North America which was in the field three years. In 1862 he returned with an extraordinary amount of material in all departments of natural history. His specimens were the property of the Smithsonian Institution, but there had been an understanding that a full series of duplicates should be given to any society or institution he might name that would provide suitably and care for them. He designated as the recipient of these duplicates the Chicago Academy of Sciences, and under the stimulus given by this valuable donation the academy again reorganized, and a new charter was secured from the state legislature.

Professor Louis Agassiz, of Harvard University, had addressed the members of the academy on February 22, 1864, at the residence of Mr. Edmund Aiken, when he had testified to the great value of Mr. Kennicott's work. As a result, about $60,000 had been raised, and the academy placed upon an enduring foundation.

Mr. Kennicott was elected the curator of the academy. In March, 1865, the Western Union Telegraph Company planned an expedition for the purpose of establishing a route for a telegraph line to connect North America with Asia across Bering Strait. The company very generously offered to naturalists the opportunity to conduct scientific investigations in a region at that time scarcely known and almost inaccessible. Mr. Kennicott, with others, joined the expedition, sailing from New York on March 21, 1865. While at San Francisco he was notified that at a meeting on April 7, 1865, he had been elected director of the academy. On May 13, 1866, he died suddenly, while alone, on the banks of the Nulato river in Alaska.

On November 12, 1866, Dr. William Stimpson was elected director of the academy to succeed Mr. Kennicott. For many years Dr. Stimpson had been in charge of the invertebrate department of the Smithsonian Institution. He was the first naturalist to dredge systematically on the American coasts, beginning his operations in 1849. In 1850 he had been a student of Professor Agassiz at Harvard. In 1852 he was appointed naturalist of the United States North Pacific Exploring Expedition. During 1865 he had twice visited Washington for the purpose of selecting specimens at the Smithsonian Institution, and succeeded in obtaining very large collections in nearly all the branches of natural history. He added largely to these from his private collection.

On June 7, 1866, the collections and rooms of the academy were seriously damaged by fire. In his report Dr. Stimpson stated that

> Half the animals and birds were lost; the extensive collections of birds' nests and eggs were mainly consumed; nearly all the insects were destroyed; the dried crustaceans and echinoderms were all destroyed. The large herbarium was saved, with the exception of the plants of the northern Pacific expedition. The library was much damaged by water, but most of it was still in a condition to be used.

In 1867 the academy joined with the Smithsonian Institution in sending Mr. Ferdinand Bishoff on an exploring expedition for the purpose of conducting

zoological investigations along the shores of the north Pacific. The academy was to pay half the expenses and to receive half the material.

For some time the academy had been considering the construction of a new building, and the loss of its old building in 1866 stimulated it to action. A lot was purchased on Wabash Avenue north of Van Buren Street, and a fireproof building was erected thereon. The supposed fireproof character of this new building which at that time was unique in the construction of museum buildings, led many institutions, as well as private individuals, to send large and valuable collections and private libraries rich in particular departments of science to the academy. This was especially true of the Smithsonian Institution.

At the beginning of the year 1871 a brilliant future seemed assured. Valuable material constantly flowed under the care of the academy, and the enthusiasm of the members steadily increased under the wise guidance of Dr. Stimpson. Besides this, the academy had a large hold on public esteem. It became popular to be scientific, and to foster those things which would aid and advance the investigation of the truths of nature. But on the night of October 9, 1871, the academy's building was completely destroyed by fire, with all its contents, and a further blow was the death of Dr. Stimpson on May 26, 1872.

After a long period of troubles and discouragements, the Matthew Laflin Memorial building was built, Mr. Laflin contributing $75,000 and the Lincoln Park commissioners $25,000. This building was dedicated and opened to the public on October 31, 1894.

In 1892 the academy had inaugurated the natural history survey of Chicago and vicinity. This, together with the work of popularizing science, now forms its chief activity.

The first movement which led to the organization of the Chicago Astronomical Society was made in December, 1862, within the old University of Chicago (Douglas University). It arose from a visit from The Reverend M. R. Fory, who came to Chicago in an endeavor to sell a telescope manufactured by Mr. Fitz, an optician of New York. The price of the instrument was stated to be $8,000. In order to awaken a proper interest in the purchase of such an instrument, and in the establishment of an observatory, it was determined that the Reverend Mr. Fory should lecture on astronomy in Bryan Hall. This lecture was delivered on December 8, 1862.

After the lecture a meeting was organized, at which Mr. J. Young Scammon was asked to preside, and a committee of five was then appointed with a view of purchasing the "Fitz glass" and of establishing an observatory. The committee held a meeting on December 13, and still another on December 15, to consider questions connected with the purchase of the "Fitz glass." But the committee had learned from Baron Brünnow, of the Ann Arbor University, something of the great telescope made by Alvan Clarke and Sons of Cambridge, Massachusetts, for the University of Mississippi which, on account of the breaking out of the Civil War, had been left on the hands of the manufacturers.

The committee determined upon the purchase of the Clarke telescope, and thereby Chicago became the possessor of what was then the largest and best refracting telescope in the world, with a diameter three inches greater than that of the great telescope at Cambridge, and greater than that at Pulkowa in Russia, the largest refracting telescope in Europe. This telescope, upon being pointed at Sirius, discovered the hitherto unseen, though suspected, dark companion of Sirius. On March 22, 1863, this telescope was purchased.

The observatory tower was built by Honorable J. Young Scammon on the west side of the University of Chicago building. It was named by the trustees Dearborn Observatory in memory of Mr. Scammon's first wife.

The Chicago Astronomical Society was organized in November, 1863, and incorporated by the legislature on February 19, 1867. On July 14, 1887, the society was served with a court order to vacate by October 1 the site on the University of Chicago grounds as a result of the financial difficulties in which the university had become involved. On August 10, 1887, the society voted to accept the offer of a site at Evanston, Illinois, that had been made by the Northwestern University, and the new Dearborn Observatory was dedicated at Evanston on June 9, 1889.

In the summer of 1863 there was established a museum, subsequently known as Wood's Museum, of which we read in the *Chicago Tribune* of July 6:

> We make the announcement with pleasure that, through the liberality of two of our public-spirited citizens, the St. Louis Museum has been purchased, and will soon be removed to, and permanently located in, this city. This Museum is much the largest in the West, and in several of its features the choicest one in the United States.

The catalogue of the museum, dated August 17, 1863, bore on the cover the following:

> A complete guide to the Chicago Museum, including a description of the wonderful antediluvian monster, the great Zeuglodon, catalogue of birds, quadrupeds, fishes, reptiles and insects; microscopes, stereoscopes, cosmoramas, philosophical instruments, minerals, shells, mummies, models and curiosities. Admittance twenty-five cents. Kingsbury Block: Randolph Street, between Clark and Dearborn Streets.

The museum was first opened to the public on August 17, 1863.

The original collection was assembled by Edward Wyman, and consisted chiefly of such objects as were commonly exhibited in museums at that time. But among the attractions was the skeleton of a *Zeuglodon* 96 feet long.

On the upper floor was the "hall of paintings," where some really fine works of art were shown. In an exhibition hall at the rear there was nightly unrolled a panorama of the city of London. It cost an additional fifteen cents to see this. So popular was this museum that during the first six weeks of its existence fully ten thousand visitors were entertained there.

The museum consisted of six distinct departments. According to the guide to the collections it contained at the time of its establishment 62 cases including chiefly birds, 13 cases of insects, 1 case of American bird's eggs, 4 cases of sea-shells, 4 large cases of minerals, 5 cases of miscellaneous curiosities, 27 busts, some Egyptian mummies, 58 miscellaneous specimens not in cases (zoological, anthropological and geological), a model of the Parthenon, and a model of the capitol at Washington.

A change in the management took place on January 25, 1864, at which time Colonel J. H. Wood became the proprietor. Among the new attractions in the department of natural history was a sea-lion from Barnum's collection.

The name of the museum was changed to Aiken's Museum in November, 1869, but in June, 1871, Colonel Wood again resumed the management, and the name Wood's Museum was restored. This museum and its contents were entirely destroyed by the great fire on the night of October 9, 1871.

It is of interest that the *Zeuglodon* skeleton was the first, and only complete, skeleton of this great creature ever found, with the only complete skull. Another specimen of special interest in this museum was the head of a fossil beaver (*Castorides ohioensis*), which was later acquired by the Chicago Academy of Sciences. Shortly before the fire Dr.

Stimpson sent it to Professor Agassiz at Cambridge, Massachusetts, who wished to make a plaster cast of it. It was not returned until after Professor Agassiz's death in 1873 and so escaped destruction.

During the Civil War Dr. C. V. Riley published a number of articles on entomology in the *Prairie Farmer*, with which he later became associated as reporter, artist and editor of the entomological department. This led to his appointment as state entomologist of Missouri in 1868, and through this appointment subsequently to the organization and development, under his guidance, of what has now become the Bureau of Entomology in the Department of Agriculture at Washington.

The seventeenth meeting of the American Association for the Advancement of Science was held in Chicago from August 5 to 12, 1868. In his address to the members of the association Dr. Frederick A. P. Barnard, who had been the president of the association in 1866, said:

> The city which, on the present occasion, has extended to American science the encouragement of its generous hospitality, is one which has been heard of before in connection with large assemblies professing to represent our country in one or another of its aspects. But this is the first time that a great convention has been assembled here which could claim to be called in the strictest sense national; a convention having no aims likely to engender suspicion in any quarter, and intent on no proceedings liable to be watched by any jealous eyes. For this is the first of the national conventions which the political, social, commercial and intellectual prominence of Chicago has attracted to this spot, of which the declared platform has been entirely catholic and universally acceptable; the first which could justly hope to enlist the sympathies of all parties, creeds, all states, all sections alike. It is gratifying to know that there is one subject in regard to which the whole world of mankind have a common interest, one subject on which there can be but one party. Such a subject is that which occupies us. For the object of science is truth. Its progress is the progress of civilization, its encouragement is the encouragement of the arts of life, and the enlargement of the comfort and the happiness of the human race.

Two hundred and fifty-nine names were registered in the book by members who attended the meeting, and 475 new members were chosen. One hundred and fifty-one papers were presented, most of which were read, and some of them discussed at great length.

The sessions of the association were held partly in the Library Hall of the Young Men's Association and other rooms of the same building, and partly in the lecture rooms of the First Baptist Church.

At this meeting Colonel J. W. Foster, of Chicago, was elected president, and the association voted to hold its next meeting at Salem, Massachusetts.

It is recorded that through the extraordinary liberality of the directors of many of the railroads that center in Chicago, the members of the association had an opportunity, after the final adjournment of the meetings, to make excursions to points of scientific interest, and not a few availed themselves of the privilege to visit the Coal Valley near Rock Island, Illinois, the mines of Lake Superior, or the newly planted germs of a city on the Missouri River—Omaha. A small party proceeded from Omaha, on the invitation of Hon. W. B. Ogden and Captain J. B. Turner, over the whole length of the Union Pacific Railroad to a point more than 60 miles beyond Benton, and on the afternoon of August 17, after dining in the construction train of General Casement, rode over a mile of road which had been finished with the rails which their own train had brought forward two hours before.

The Chicago Microscopical Club, out of which grew the present State Microscopical Society of Illinois, was formed on December 12, 1868.

The scheme of holding a permanent exposition in Chicago first began to at-

tract public attention in 1871. The Chicago Inter-State Industrial Exposition Company was organized in March, 1873, and the exposition was opened to the public in September, 1873.

In March, 1885, the Chicago Academy of Sciences proposed to make its valuable collection, illustrating the several departments of natural history, a part of the regular exhibition for two years, and suitable rooms were provided for it.

At the annual meeting of the stockholders on November 14, 1885, it was moved that the executive committee inquire into the propriety of holding an "Indian Exhibition" in the building, either in 1886 or 1887. The motion was carried unanimously, and steps were taken to gather representatives of the various Indian tribes of the West and Northwest, together with their squaws, papooses, dogs, teepees and accoutrements, as well as a collection of old Indian implements and curiosities, to make an exhibition at once complete and full of historic interest.

The College of Physicians and Surgeons of Chicago, founded in 1882, was united with the University of Illinois in 1897, was separated from it in 1913, but is now again united with that university as its College of Medicine.

On May 5, 1846, a National Medical Convention of delegates from medical societies and colleges in the whole nation convened in New York City. A second meeting was held in Philadelphia in the year following, and on May 5, 1847, this body resolved itself into the American Medical Association. The "Transactions" of this association up to and including volume 33, 1882, were published in Philadelphia. This series was continued as the *Journal*, which, beginning in July, 1883, has been published in Chicago, where the headquarters of the association now are. In 1930 the membership of the American Medical Association was 98,000.

In 1888 Mr. John D. Rockefeller, in cooperation with the American Baptist Education Society, took steps looking to the establishment of a new University of Chicago, contributing $600,000 under the stipulation that a further $400,000 should be raised. This requirement was soon met, and in addition a suitable location valued at $125,000 was donated by Mr. Marshall Field, so that in June, 1890, the Baptist Education Society was able to grant a charter, and in September, 1890, a board of trustees of 21 members was selected. The university was formally founded in 1892. It is privately endowed and coeducational, and non-sectarian, although of its 30 trustees 18 must be Baptists.

The original faculty consisted of 30 professors, 35 associate and assistant professors, 5 docents, 27 instructors and lecturers, 20 senior fellows, 15 junior fellows, 8 honorary fellows and 4 non-resident fellows. Among the professors were 9 former presidents of other institutions of higher learning, and 2 past presidents of the association, Thomas Chrowder Chamberlin and Albert A. Michelson. Other well-known men on the faculty in the early years were Charles O. Whitman, Jacques Loeb, Samuel W. Stratton, George E. Hale, Adolph C. Miller and Edward W. Bemis. Two members of the faculty have received the Nobel prize in physics, Robert Andrews Millikan (1896–1921) and Arthur Holly Compton (1923–).

The chief aims of the university have been research and graduate education, following the ideals set by its first president, William Rainey Harper, and expressed in its earliest organization.

The university includes 123 professors having to do with science, 64 on the faculty of arts, literature and science, 34 in the Rush Medical College and 25 on the faculty of medicine in the Ogden School of Science.

That a university press should form

an integral part of the University of Chicago was planned from the beginning, and the University of Chicago Press, patterned more or less after the Oxford University Press in England, was the first university press to be established in America. In the 40 years of its existence the output of the University of Chicago Press has grown from 6 books to more than 900 books and 15 scholarly journals. During its fiscal year 1931–32 no less than 116 books were published.

In October, 1892, after consultation with Professor George E. Hale and President Harper, of the University of Chicago, Mr. Charles T. Yerkes gave the order for the forty-inch lens, then unfinished, in the possession of Alvan Clarke, of Cambridge, Mass., and for an equatorial mounting for it to be constructed by Messrs. Warner and Swasey. The mounting was prominent among the exhibits at the World's Columbian Exposition in 1893. The operations of building, mounting and adjusting were completed in October, 1897, when the work of the new observatory was formally inaugurated by a well-attended congress of leading astronomers.

The Field Museum of Natural History was established in 1893 at the close of the World's Columbian Exposition by a gift of $1,000,000 from Marshall Field. It was opened in the former Palace of Art of the exposition with material obtained by gift and purchase at the exposition. In 1908 the founder bequeathed a further $8,000,000, half for a building fund and half for endowment. The present building was opened in 1921.

The John Crerar Library was incorporated on October 12, 1894, and organized on January 12, 1895. This is a free public reference library of scientific and technical literature, its special field being the natural, physical and social sciences and their application. The administration of the library is not organized into departments, except in regard to the medical sciences. When the Chicago Public Library was established, shortly after the great fire in 1871, it received as a nucleus for a medical library the collections of the Chicago Medical Society, the Medical Press Association and the Homeopathic Relief Association, with the understanding that the city would build up a medical reference collection. But the Public Library did not have sufficient space for the purpose, and its directors doubted if it came within its proper scope. The Medical Library Association of Chicago was then incorporated to do the work, but the expense proved to be too great for its resources, and the trustees of the Newberry Library were asked to accept as a gift the collection already made, and to carry on the work. In August, 1907, the books were transferred to the John Crerar Library, together with the library of Dr. Nicholas Senn, including the notable surgical library of Dr. Wilhelm Baum, of Göttingen, the physiological library of Dr. Emil Du Bois-Reymond, of Berlin, and a general collection made by the book dealer, E. Geibel, of Hanover. The medical department of this library ranks well among the medical libraries of the world.

The American Association for the Advancement of Science met in Chicago for the second time from December 30, 1907, to January 4, 1908. This was its fifty-eighth meeting. The number of members officially registered at this meeting was 725. Members of affiliated societies who were not members of the association registered to the number of 185. The total membership at that time was 4,727.

At the second Chicago meeting a letter was received from President Theodore Roosevelt, dated December 31, 1907, enclosing a copy of a letter which on November 11 he had addressed to the governors of each of the several states

relative to a proper conservation of the natural resources of the country, and inviting the governors, with their experts, to meet in conference on this subject at the White House in Washington from May 13 to 15, 1908. The President invited the cooperation of the association in properly bringing this matter before the public, and also invited the president of the association to take part in the conference.

The seventy-third meeting of the association, the third Chicago meeting, was held from December 27, 1920, to January 1, 1921.

The Museum of Science and Industry was established in 1926. It was founded by Julius Rosenwald with a gift of $3,000,000 for equipment and the preparation of collections and exhibits. The original name—Rosenwald Industrial Museum—was changed in 1929. Building was begun in 1929 with the proceeds of a $5,000,000 bond issue authorized by the South Park Commissioners. The building is a reconstruction in stone of the Fine Arts Building of the 1892 World's Columbian Exposition.

The Adler Planetarium and Astronomical Museum was presented to the South Park Commissioners by Max Adler in 1930. It is situated on an artificial island in Lake Michigan, which was built by the commissioners.

In this country memorials to scientific men outside of academic institutions are rather rare. It is of interest, therefore, to recall the excellent bronze statue of Karl von Linné (Linnaeus) in Lincoln Park, which was the gift of the Scandinavian citizens of Chicago.

This brief sketch of the history of the development of Chicago as a scientific center is only a portion of the picture as a whole. The following additional organizations are either located in Chicago, or have their headquarters there:

Hahnemann Medical College and Hospital of Chicago (established in 1855 and now affiliated with Valparaiso University, Valparaiso, Indiana).

Chicago Historical Society (1856).

Chicago College of Pharmacy (established in 1859; in 1896 it became the School of Pharmacy of the University of Illinois).

American Veterinary Medical Association (1863).

Chicago Dental Society (1864).

American Association of Engineers (1869).

American Library Association (founded in Philadelphia in 1876).

Chicago Pathological Society (1878).

The Art Institute of Chicago (1879).

Illinois Pharmaceutical Association (1880).

National Association of Power Engineers (1882).

American Surgical Association (organized in 1880 in Philadelphia).

American Association of Railway Surgeons (1888).

Association of American Medical Colleges (1891).

American Railway Bridge and Building Association (1891).

American Numismatic Association (1891).

Armour Institute of Technology (1892; there are 8 professors of scientific subjects).

Walker Museum of Paleontology (1893).

William Webb Museum of Northwestern University Dental School (1896).

Geographic Society of Chicago (1898).

American Railway Engineering Association (1899).

Frederick Robert Zeit Museum of Pathology of Northwestern University (1899).

American Philosophical Association (1900).

German-American Historical Society of Illinois (1900).

Classical Museum of the University of Chicago (1900).

College of Dentistry of the University of Illinois (1901).

The Central Association of Science and Mathematics Teachers, Inc. (1902).

John Rockefeller McCormick Memorial Institute for Infectious Diseases (1902).

Chicago Urological Society (1903).

National Association Boards of Pharmacy (1904).

American Sociological Society (1905).

Chicago Tuberculosis Institute (1906).

Swedish Engineers' Society (1908).

Illinois Society for Mental Hygiene (1909).

Society of Medical History of Chicago (1909).

Abbott Laboratories (1910).

American Institute of Refrigeration (1910).

Nelson Morris Institute for Medical Research (founded as part of the Michael Reese Hospital).

Federation of American Societies of Experimental Biology (1913).

American College of Surgeons (1913).

Eugenics Education Society (1914).

American Association of Industrial Physicians and Surgeons (1915).

Chicago Society of Internal Medicine (1915).

Institute of Medicine of Chicago (1915).

Central States Pediatric Society (1915).

Clay Products Association (1916).

Research Laboratory of the Portland Cement Association (1916).

Society of Industrial Engineers (1917).

American Bronchoscopic Society (1917).

Oriental Institute of the University of Chicago (1919).

National Dairy Council (1919).

Electric Steel Founders' Research Group (1920).

American Specifications Institute (1921).

American Physiotherapy Association (1921).

American Congress of Physical Therapy (1922).

National Conference on Pharmaceutical Research (1922).

Acoustical Society of America (1929).

In addition to these, there are the following:

Radiological Society of North America.

American Boa-d for Ophthalmic Examinations.

Public Health Institute of Chicago.

American Dental Association (with 35,000 members).

American Dietetic Association.

Illinois Audubon Society.

American Hospital Association.

Northwestern University Museum of the College of Liberal Arts.

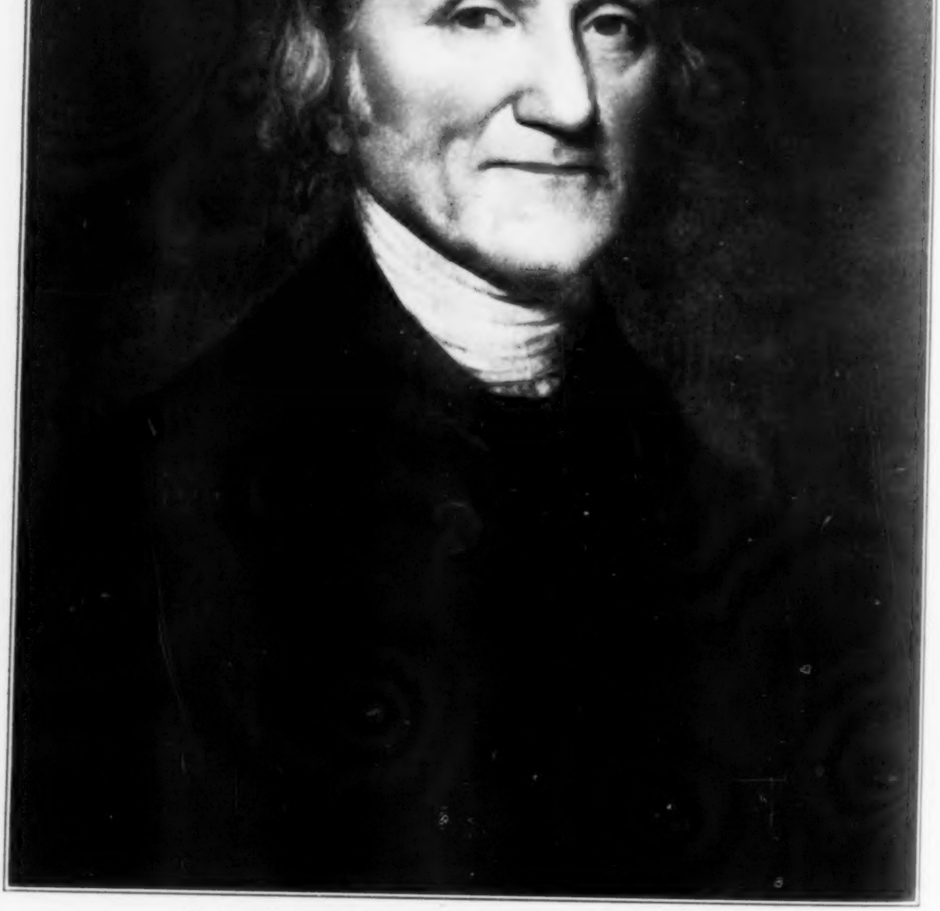
Natural History Museum of the Loyola University.

The Museum of the Presbyterian Theological Seminary.

There are 28 libraries in Chicago in addition to those connected with institutions.

As a scientific center Chicago is unique among the cities of the world. Here the scientific spirit has grown up in an atmosphere of endemic curiosity. It was for the most part a local development having its origin in the inquiring minds of energetic and intellectual people who had more or less completely broken away from the old traditions. So it has grown up more largely along economic and practical than along cultural lines. The possibilities of applying science for the benefit of all have taken precedence over the cultural aspects. But at the same time the cultural side of science has by no means been neglected.

In no other city is science, from our American view-point and in harmony with our American spirit and ideals, more highly developed than in Chicago.



THE STUART PORTRAIT OF JOSEPH PRIESTLEY

THE PROGRESS OF SCIENCE

JOSEPH PRIESTLEY[1]

THE numerous exercises held in commemoration of the bicentenary of the birth (March 13, old style, 1733) of Joseph Priestley by colleges, universities and various religious organizations, both in this country and abroad, testify to the interest in the work and the appreciation of the influence of this remarkable man. Best known for his work in theology and science, he made his influence felt also in the fields of politics, sociology, philanthropy, history, philosophy and education.

In religion Priestley was a dissenter and in his time in England these beliefs were very unpopular. Along political lines his democratic ideas were far in advance of his period and equally unpopular. While calm and dispassionate in the manner in which he expressed his views he nevertheless was unequivocal and persistent. His constant repetition of his beliefs irritated his opponents. It has been said that he "acquired the reputation of being the most cantankerous man of his time . . ." This antagonism culminated in the riots in Birmingham in 1791 and carried with it so much of persecution and discomfort that he emigrated to America. Not every one was against him. His close friends were ardent supporters and would have had him remain. Even among the opponents of his political and religious beliefs there were many who regretted his entry into controversial discussions and who hoped that he might spend all his energy in philosophical pursuits.

Priestley and his wife sailed for America on April 8, 1794, and after a tiresome voyage of nearly two months arrived in New York on June 4. They were met by their son Joseph and his wife, who were already established at Northumberland, Pennsylvania. After being cordially entertained in New York and in Philadelphia, as they passed through, the party arrived at Northumberland about August 1. Here, except for short visits to Philadelphia, Priestley lived until his death, on February 6, 1804.

Priestley's fame as a clergyman and as a scientist had preceded him to America. On his arrival in New York he was visited by Governor Clinton, Dr. Prevost, bishop of New York, the principal merchants and by deputations from political, educational and scientific organizations bringing messages of welcome. To most of these Priestley found time to make appropriate response. The *American Daily Advertiser* of that time paid the following tribute to him, in an editorial: "The name of Joseph Priestley will be long remembered among all enlightened people; and there is no doubt that England will one day regret her ungrateful treatment to this venerable and illustrious man."

Priestley's replies to the messages of welcome were free from rancor but were quite frank with respect to the treatment accorded him in England. And as always he expressed freely his own views on religious and political subjects. Not long after the publication of these addresses and his replies he became the subject of an attack by William Cobbett, an Englishman, who wrote under the pen-name of Peter Porcupine. Priestley was much annoyed by this writer, whose attacks continued periodically until the latter returned to England in 1800. During the remainder of his life, Priestley was occasionally disturbed by similar

[1] In the preparation of this note on Priestley, the writer has drawn freely on articles by Dr. C. A. Browne, Dr. Lyman C. Newell and the late Dr. Edgar Fahs Smith.

PRIESTLEY'S HOME AT NORTHUMBERLAND, PA.
VIEW FROM THE SOUTHWEST SHOWING THE PRIESTLEY MUSEUM.
(OWNED BY THE PENNSYLVANIA STATE COLLEGE.)

charges of a biased and unfair nature. Meanwhile, the better publications were coming to his support and thoughtful men of the country who admired his fair attitude on all controversial questions and who appreciated his achievements in science were paying him increased honor and respect.

With all his many interests Priestley was first of all a minister—a theologian. He was ordained while at Warrington. The preparation of his articles on religious subjects claimed much of his time up to the very end. His writings in this field and on related subjects are voluminous and are sufficient in themselves to earn for him a place of honor. The last ten years of his life, which were spent at Northumberland, were not unfruitful. Here were completed his "Church History," his "Notes on the Scriptures," "Socrates and Jesus Compared" and his "Comparison of the Institutions of Moses with those of the Hindoos." On his visits to Philadelphia, he was delighted to occupy the pulpit when opportunity offered. Here he established the first Unitarian church in America.

In educational matters Priestley always maintained a live interest. For a time in England he was a teacher at Warrington Academy. At Northumberland he gathered a class of fourteen young men who had adopted his Unitarian ideas, to whom he lectured on theology and philosophy. He was offered the professorship of chemistry at the University of Pennsylvania, but declined it, influenced in this action by the state of his health and the difficulty of removing his books and apparatus to Philadelphia, and also by the expectation that in a year or two a college would be established at Northumberland. His interest in education, his accomplishments in science and his liberal views on politics brought about a close friendship with Thomas Jefferson. He was frequently consulted by Jefferson with regard to plans for a university which the latter was proposing to establish in Virginia. In the "Hints Concerning Public Instruction" which he

MAIN HALLWAY OF THE PRIESTLEY HOUSE

prepared for Jefferson are expressed many views on education which would be considered modern to-day. The establishment of an academy at Northumberland in which he would feel free to impart his Unitarian doctrines was a fond but unfulfilled hope.

To Priestley science was an avocation, which is no reflection on his interest or his achievements in that field, rather the contrary. His attention was only turned to chemistry when in his thirties, by Dr. Matthew Turner, of Liverpool, who lectured on the subject at Warrington Academy while Priestley was a teacher there. His interest in science was further stimulated by Benjamin Franklin, whose acquaintance he made on one of Franklin's visits to London. While living in Leeds his home adjoined a public brew house. He was led to amuse himself by making experiments on carbon dioxide (fixed air) which is produced in the fermentation process. With very little funds at his command and with no background in science he was under the necessity of devising both apparatus and method of attack.

His first paper on "Pneumatic Chemistry," the results of his experiments at Leeds, was published in 1772. It was immediately translated into French and attracted a great deal of attention to the subject. For this paper on soda-water he received in 1773 the Copley Medal.

In 1774 came the discovery for which he is best known—that of oxygen. With but two years in science it was rare good fortune. That it was not wholly accidental is evidenced by the long series of gases that Priestley discovered. Oxygen, ammonia, hydrogen chloride, hydrogen sulfide, sulfur dioxide, nitric oxide, nitrous oxide and carbon monoxide comprise the list. It is an imposing list and fixes for all time Priestley's place in chemistry.

Soon after his arrival in Northumberland, Priestley made plans for a house and a laboratory. For a time he had only one room in his son's house for his library and apparatus and this was so cold that it was impossible for him to work in winter. His most important

PRIESTLEY'S GRAVE AT NORTHUMBERLAND, PA.

discovery in the investigations made at Northumberland was that of carbon monoxide, which he obtained in 1799 in several ways. Other investigations include spontaneous combustion, diffusion of gases, the liberation of air from water and the action of caustic alkalies on flint glass. His dominating purpose at this time was to overthrow the French school of chemistry proposed by Lavoisier. During these years he finished his last scientific work, "Doctrine of Phlogiston Established."

Priestley would never accept the simpler French view. The results of his experiments were susceptible of two interpretations and were frequently used to support the views of his opponents. His experiments were admirably done, but he failed in the interpretation of their theoretical relations. It has been said of him—"In theory he had no instinct for guessing right . . . he may almost be said to have had a predilection for the wrong end."

Priestley's coming to America aroused a live interest in chemistry which has in no sense diminished since his time. His library and laboratory at Northumberland were among the best equipped of his time. He appeals strongly because of the persistency of his efforts in research. The influence of his accomplishments can hardly be overestimated.

G. C. Chandlee

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Pennsylvania State College

THE ANNUAL MEETING OF THE NATIONAL ACADEMY OF SCIENCES

The National Academy of Sciences has reached the age of threescore years and ten. This is, however, not an old age for a scientific society; the Accademia Nazionale dei Lincei at Rome was founded in 1603, The Royal Society in 1645, The Prussian Academy in 1700, and The American Philosophical Society in 1727. The National Academy of Sciences was incorporated by Act of Congress on March 3, 1863, and held its first meeting in New York City on April 22, 1863, for organization purposes only. Its first meeting with scientific sessions was held in Washington from January 4 to 9, 1864; since then it has held, each year, an annual meeting in Washington and has devoted the greater part of the meeting to sessions for the presentation and discussion of scientific papers. At the recent meeting from April 24 to 26 in Washington, at the Academy building, sixty-six papers were read from the following fields of science: Mathematics, 2; astronomy, 7; physics, 16; chemistry, 3; geology, 2; paleontology, 2; oceanography, 1; meteorology, 2; botany, 2; biochemistry, 1; biophysics, 2; physiology, 14; embryology, 1; genetics and evolution, 5; pathology, 1; psychology, 3; anthropology, 2. Of these papers 45 were given by members of the academy, 5 by invited guests and 16 by scientists introduced by members. Two sessions were held each morning and afternoon on Monday and Tuesday. The average attendance at the sessions was 450; the papers were unusually interesting and were freely discussed. On Monday evening Dr. Thomas Hunt Morgan, former president of the academy, delivered a public lecture on "The Bearing of Genetics on the Theory of Evolution" to an appreciative audience of six hundred.

One of the most important communications was the address given at the annual dinner on Tuesday evening, by the president of the National Academy of Sciences, on the status of research in science in this country. President Campbell emphasized the importance of research and the need for its continuance. To quote from his address:

DR. GRIFFITH C. EVANS
Professor of pure mathematics,
Rice Institute.

DR. J. F. RITT
Professor of mathematics,
Columbia University.

DR. S. A. MITCHELL
Director, Leander McCormick Observatory,
University of Virginia.

HAROLD D. BABCOCK
Physicist, Mount Wilson Observatory.

In my opinion, the products of research and invention in the domain of the physical and biological sciences have been more potent in advancing the state of civilization on the earth from its low level of the fifteenth century to its high level of the twentieth century than have all other forces combined. I do not expect universal acceptance of this thesis, but I am prepared to defend it. There is no question that many other forces, both idealistic and practical, have been exceedingly influential and powerful in behalf of the nations and their peoples, but in the main those forces would not have existed, or certainly could not have operated, if the physical and biological sciences had not provided the mental and moral attitudes, the opportunities, the *open sesame* that permitted them to go out into the great world and exert their effective and beneficent influences. . . .

BANCROFT GHERARDI
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I have been speaking of research activities and research results of the present and of the recent past; but what of the future, even of the immediate future? They threaten to be very different. A condition of intense anxiety on this subject exists in nearly all our universities, in the research institutions, in the learned societies in general, in the research organiza-

tions supported by the Government of the Nation, and with countless thousands of public-spirited and wide-awake citizens who have a fair comprehension of what scientific discovery, through experimentation and research, have done for humanity. In many universities, especially state universities, where research, sympathetically nurtured and supported through the years, has brought forth new knowledge of tremendous importance to the welfare of the nation, the degree of existing anxiety as to what may happen can be said to have approached, here and there, the stage of fear. The legislatures of the majority of our states are now in session, and they have the duty of appropriating funds for the support of their respective educational institutions through the

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next two years. The attitude of many, perhaps all the legislatures toward research at public expense may fairly be described as unsympathetic and, in some cases, I am informed, as severely hostile. I need not say to this audience that a university, shorn of its research activities and deprived of the scholarly atmosphere that research develops, will eventually differ but little in character from what we might call a *higher high school*. The name "university" will remain, but the qualities special to a real university will dwindle and disappear. The Book of Great Wisdom, tried

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and proved through the centuries, says that "Where there is no vision, the people perish." Equal confidence may be placed in the thesis, "Where there is no research, the universities perish." The governments, the universities and the peoples in Europe and in many other parts of the world understand this principle perfectly. The universities in those countries, with few exceptions, are national, or state, or municipal universities, financially supported in major degree by their governments.

Five medals were awarded at the annual dinner:

The Alexander Agassiz Medal for Oceanography, awarded to Albert Defant, of the Institut für Meereskunde, Berlin, Germany, for his studies on atmospheric and oceanic circulation and his notable contributions to theoretical oceanography. The presentation speech was made by Dr. Henry B. Bigelow, of the Woods Hole Oceanographic Institution. The medal was accepted by His Excellency, the German Ambassador, on behalf of Dr. Defant.

The Public Welfare Medal of the Marcellus Hartley Fund—for eminence in the application of science to the public welfare—was awarded to William Hallock Park, of New York City, for his work as head of the research laboratories of the New York City Department of Health and as a pioneer and leader both in research and in the application of scientific discovery to the prevention of disease. The presentation speech was made by Dr. Simon Flexner, of the Rockefeller Institute for Medical Research.

DR. A. R. DOCHEZ
PROFESSOR OF MEDICINE, COLUMBIA UNIVERSITY.

DR. OSWALD T. AVERY
MEMBER, ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH.

The John J. Carty Medal and Award for the Advancement of Science was awarded a year ago to John J. Carty, a member of the academy, in whose honor the medal was established for his distinguished accomplishments in the field of electrical engineering, particularly as they have influenced the development of electrical communication, and also his noteworthy influence on the introduction of fundamental science and of the methods of sound scientific research as an integral and powerful tool of industrial development. Dr. Carty died on December 27, 1932. The medal was received by his son, Dr. John Russell Carty. The presentation address was made by Dr. F. B. Jewett, president of the Bell Telephone Laboratories.

The Henry Draper Medal was awarded to V. M. Slipher, a member of the academy, at Lowell Observatory, Flagstaff, Arizona, in recognition of his spectroscopic researches, among the most important of which may be mentioned: (1) The discovery of "stationary"

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calcium lines in stellar spectra; (2) the development of efficient methods of observations of the spectra of spiral nebulae and the securing of the first observations of their radial velocities; (3) observations of bright lines and bands in the spectra of the night sky. The presentation address was made by Dr. H. N. Russell, of Princeton University.

The Mary Clark Thompson Medal was awarded to Francis Arthur Bather, of Wimbledon, England, for his distinguished services in the fields of paleontology and geology. His principal scientific contributions are his "Crinoidea of Gotland," published in Stockholm in 1893, his work on the Triassic echinoderms of Bakony in 1909, his chapters on echinoderms in Lankester's "Treatise on Zoology," and his studies on the Edrioasteroidea in 1915. The presentation address was made by Mr. E. W. Berry, of Johns Hopkins University. The medal was received on behalf of Dr. Bather by Dr. Ralph Howard Fowler, of Cambridge University, England.

At the annual business meeting the resignation of Dr. David White as vice-president, because of ill health, was accepted with regret and with expressions of appreciation of his long and faithful services to the academy. Dr. Arthur L. Day, of the Geophysical Laboratory of the Carnegie Institution of Washington, was elected vice-president for a period of four years, beginning July 1, 1933.

Two members of the council were re-elected for a period of three years:

- Dr. J. McKeen Cattell, Garrison-on-Hudson, N. Y.
- Dr. Karl T. Compton, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Fourteen new members were elected:

- Dr. Oswald Theodore Avery, bacteriologist, Rockefeller Institute for Medical Research, New York, N. Y.
- Harold Delos Babcock, astrophysicist, Mt. Wilson Observatory of the Carnegie Institution of Washington, Pasadena, California.
- Dr. Thomas Barbour, zoologist, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.
- Dr. Alphonse Raymond Dochez, professor of medicine, Columbia University, New York, N. Y.
- Dr. Bernard Ogilvie Dodge, botanist, New York Botanical Garden, New York, N. Y.

DR. W. R. MILES

PROFESSOR OF PSYCHOLOGY, YALE UNIVERSITY.

Dr. Eugene Floyd DuBois, professor of medicine, Cornell University Medical College, New York, N. Y.

Dr. Griffith Conrad Evans, mathematician, Rice Institute, Houston, Texas.

Bancroft Gherardi, electrical engineer, American Telephone and Telegraph Company, New York, N. Y.

Dr. Herbert Eugene Ives, physicist, Bell Telephone Laboratories, New York, N. Y.

Dr. Walter Richard Miles, psychologist, Yale University, New Haven, Connecticut.

Dr. Samuel Alfred Mitchell, astronomer, Leander McCormick Observatory, University, Virginia.

Dr. Linus Pauling, chemist, California Institute of Technology, Pasadena, California.

Dr. Joseph Fels Ritt, mathematician, Columbia University, New York, N. Y.

Dr. Henry Clapp Sherman, chemist, Columbia University, New York, N. Y.

In demonstration of a paper read on Tuesday morning, April 25, by Dr. F. B. Jewett on "Perfect Quality and Auditory Perspective in the Transmission and Reproduction of Music," a symphony concert, sponsored by the National Academy of Sciences, was given in Constitution Hall, Washington, D. C. The concert program was rendered by the Philadelphia Symphony Orchestra in Philadelphia; the music was transmitted by three telephone lines to Washington, where it was received and the quality of the reproduction controlled by Music Director Leopold Stokowski to give spatially-accurate and perfect-quality musical rendering, and also to increase or diminish the volume from the whole or parts of the orchestra, or to vary the volume relationship between a voice and the orchestra, thus creating effects not heretofore attainable. On the program were included: Bach, "Toccata and Fugue in D Minor"; Beethoven, "Symphony No. 5 in C Minor"; Debussy, "L'après-midi d'un Faune"; and Wagner, Finale of "Götterdämmerung." Immediately preceding the concert President Campbell explained briefly its purpose and called attention to the fact that music was transmitted over the telephone, for the first time, 56 years ago and was sent from Philadelphia to Washington. During the intermission in the concert program, Dr. Harvey Fletcher, of the Bell Telephone Laboratories, explained and illustrated the methods by which the extraordinary effects were obtained. At the close of the concert Dr. Leopold Stokowski gave a brief analysis of the possibilities made available to musicians by the new methods which have been developed and of their influence on the development of music. Members of the academy and many others attending the concert were convinced that the demonstration marked a notable event in the history of music.

The present membership of the academy is 279, with a membership limit of 300; there are 44 foreign associates with a limit of 50. A total of 125 academy members and one foreign associate attended the meeting. The autumn meeting of the academy will be held this year in November at the Massachusetts Institute of Technology in Cambridge.

F. E. Wright,
Home secretary

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